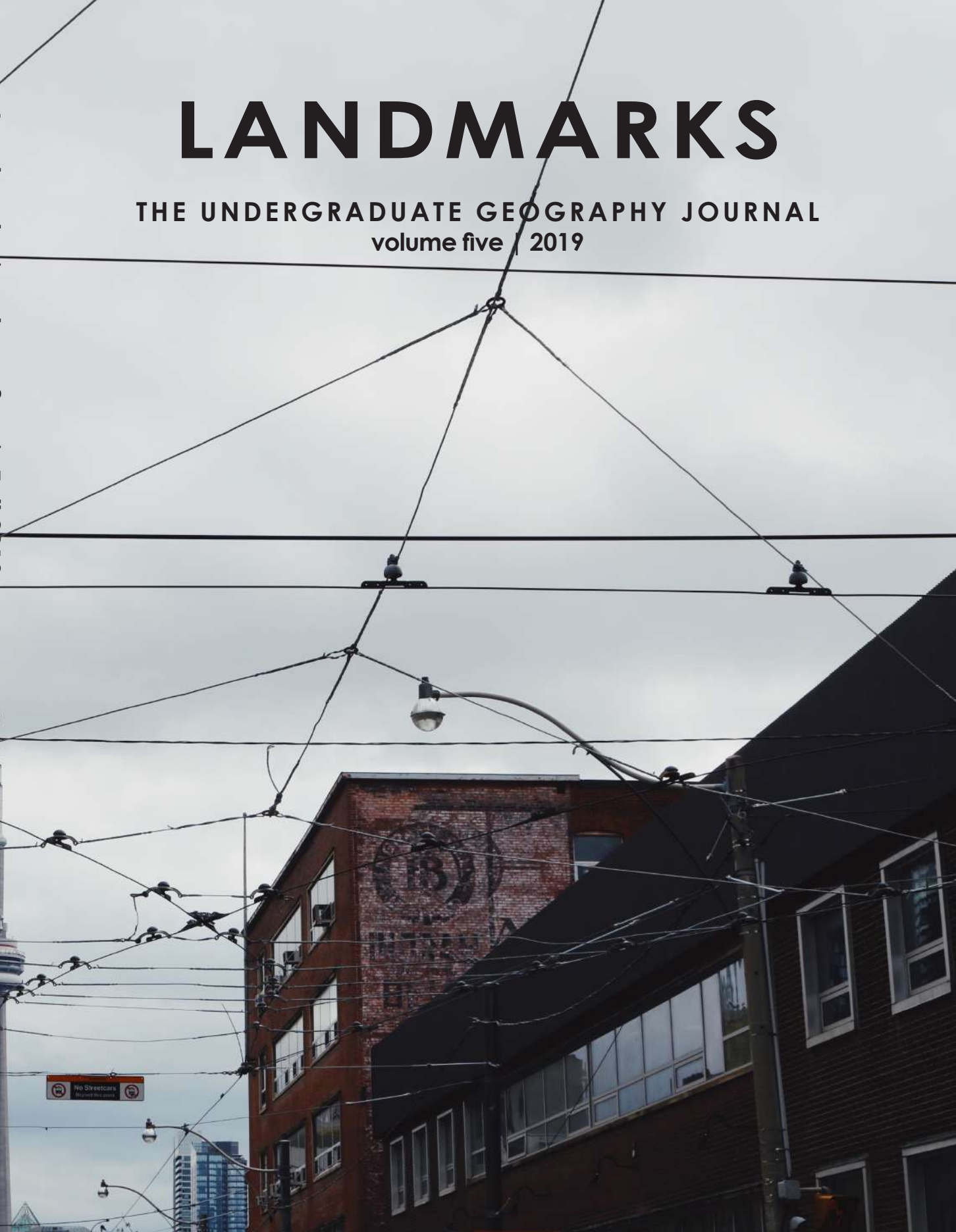


LANDMARKS

THE UNDERGRADUATE GEOGRAPHY JOURNAL
volume five | 2019



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UNIVERSITY OF
TORONTO

ABOUT THE COVER

"LANDMARKS OF TORONTO"

Cover art taken by Kathleen Dervenis and Aisha Assan-Lebbe

This photograph was taken at the intersection of McCaul and College Street on the south side of the University of Toronto, St. George campus. We felt that it was not only representative of the student experience at an institution in Toronto but that it also evoked some of the overarching "lines" of work in the journal including icons of "modernity," congestion and gentrification.



Geography & Planning
UNIVERSITY OF TORONTO



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INTRODUCTORY NOTE

We are proud to present the fifth volume of *Landmarks: The Undergraduate Geography Journal*. The journal was established in 2015 and has since featured exemplary undergraduate work from across the many streams of geography at the University of Toronto, including Human, Physical, Environmental, and G.I.S. This year's issue showcases the breadth and diversity of undergraduate work with articles that span corporeal, urban, national, and international spatial scales and employ a variety of geographical research methods including the quadrat method for vegetation sampling, legal history, quantitative demographic analysis, and conceptual genealogy.

As usual, *Landmarks* 2019 also offers an array of unusual juxtapositions: the commodification of cultural identities and Leaf Area Index calculations; impervious surface mapping and the multi-scalar politics of sex work; an historical study of gendered workplace "articulations" and an analysis of census data critiquing the promises of New Urbanism. We also, however, find key connections and complementarities: historical and contemporary processes of state-sanctioned displacements; a theoretical engagement with logistics as method and subject alongside a concrete study of the uneven costs and benefits of privatised transportation development; the role of green spaces in managing urban flooding and the importance of slope aspect in understanding processes of change in green spaces. Reading the articles together also brings to light other potential connections and research questions. What could we gain, for example, from thinking about the dynamics of urban flooding and gentrification together, particularly in the face of increasing climatic volatility? How might studies of colonial dispossession and the dynamics of forest succession work together to inform critical new approaches to environmental science and politics?

Geographers have long been at the forefront of unsettling disciplinary boundaries and mixing up methods. As the explosive popularity of the concept of the anthropocene demonstrates, there is growing appreciation of the urgent need for new generations of scholars, policy-makers and activists able to work across and transcend established boundaries of knowledge production. In bringing together editors and authors from different academic streams, *Landmarks* aims to facilitate such crosscutting conversations and relationships within the U of T Geography and Planning community. We are grateful to the Department of Geography & Planning as well as the Arts & Science Student Union for their continued support for our project and the undergraduates pursuing these diverse lines of work.

The fifth volume of *Landmarks* would not have been possible without the contributions of our dedicated editors and authors who took time during their busy semesters to compile the journal. We want to thank everyone for their hard work and patience throughout the editing process. We are also grateful to the many students who submitted their papers for consideration; as always we were impressed by breadth and caliber of the submissions. We hope that you enjoy the fifth volume of the journal and invite you to think critically about the kinds of questions raised by the articles and how the unexpected juxtapositions and complementarities highlighted here also manifest in other contemporary contexts.

Sincerely,
The Landmarks Editorial Board

AN ENCLAVE LEFT BEHIND: KOREATOWN FOR WHOM?

By Zina Fraser¹

Since cities have become defined by their global connections in the 20th century, ethnic enclaves have flourished as diasporic communities find new neighbourhoods to call home. This paper explores the evolution of ethnic enclaves over time in the context of Toronto's downtown Koreatown, formed in the second half of the 20th century. A recent shift in immigrant routes away from this area and toward the suburbs is revealed through an analysis of the decreasing population of Korean immigrants and the disappearance of community institutions in Koreatown. Consequently, it is argued that this neighbourhood has evolved from an ethnic enclave for Korean immigrants to a space of branding and consumption of Korean identity by an urban middle class.

Introduction

In the current climate of global connectivity, widespread diaspora has become a significant variable in the shifting flows of urban life. The routes traced by immigrants from their homeland to new home countries often change from one generation to the next, and roots are continually put down in the form of community institutions (churches, clubs, community hubs) and businesses to create cultural landscapes within cities, or ethnic enclaves. This has been the case for Korean immigrants in the Toronto Census Metropolitan Area, making up 61,300 people as of 2011 (Kang, 2016, p. 44). While this population's original route to Toronto traced through downtown Koreatown in the 1960s (Brown, 2012), it has since shifted toward North York (Kang, 2016, p. 44). However, the downtown area, home to only 810 Koreans as of 2016 (City of Toronto, 2018a; City of Toronto, 2018b), is still known as Koreatown, and its signage and media narratives evoke a sense of place as such. According to Qadeer et al. (2010), an ethnic enclave necessarily comprises businesses, services, and institutions for a group of residents, creating a complete community at the neighbourhood scale (p. 317). With this in mind, the existence of a Koreatown without its Korean population raises the question of for whom this place now exists.

In the paragraphs that follow, it will become clear that since immigrant routes have shifted away from Koreatown, the area has lost its population and roots in the form of community institutions, keeping only its businesses. Despite this shift in settlement patterns, the neighbourhood's continued branding with and consumption of Korean ethnic identity demonstrate that this identity has been commodified for consumption by the middle class. In this paper, I will first discuss the route traced by Koreans through Koreatown that resulted in the establishment of an ethnic enclave, complete with businesses and community institutions. Next, I will examine the change in immigrant routes away from downtown Koreatown toward North York in the 1990s to find that a shift in

¹ Originally written for ARC355: History of Urbanism with Professor Erica Allen-Kim.

community institutions toward this suburb also occurred. Finally, I will analyze marketing narratives branding Koreatown with ethnic identity and associated consumption of Korean identity to discuss the reconstruction of the neighbourhood for the middle class.

1960s-Early 1990s: Downtown Koreatown as Route to Toronto

Korean roots in the forms of both community institutions and diverse businesses were present in Koreatown when it was the main route traced by Korean immigrants through Toronto, making it a complete ethnic enclave at that time. This original route emerged in the 1960s and was the product of political context in both Canada and Korea (Brown, 2012). As instabilities endured into the 20th century, these missionaries became sources of comfort and resources, helping the first Koreans emigrate to Canada (Brown, 2012). Korean presence in Toronto specifically began with Koreans sent to the University of Toronto to study theology, many of whom were able to settle in the area due to new immigration laws, and subsequently sponsored family members to join them (Brown, 2012). Throughout the 1970s and 1980s, these immigrants put down community roots in the form of the Alpha Korean United Church at Bloor and Huron Streets (Brown, 2012), as well as newspapers and community groups further west on Bloor (Might Directories, 1976, 1983, 1990).

Community institutions located between Bathurst and Christie streets during the 1980s and early 1990s were diverse, including the Ontario Korean Businessmen's Association, the Canadian Korean Go & Chess Institute (Might Directories, 1983), the Association of Korean Canadian Scientists & Engineers, the Korean Da Book Club, the Korean-Canada Amateur Sports Association, and the Korean YMCA (Might Directories, 1990). In terms of businesses, there were professional services as well as retail establishments: Kim's Camera and Sound, Korea Travel Service, Korean & Chinese Food (Might Directories, 1983), Youn San Man Architect, Won Lee Chartered Accountant, and the Bloor Park Medical Centre that included Matthew C. Kim Family Physician among others (Might Directories, 1990). With this diverse distribution of businesses and community institutions, a Korean enclave emerged, shown in Figure 1, where the Korean community could find services, community hubs and employment.



Figure 1 Korean-owned groups and establishments in 1990 Koreatown. Data interpreted based on city business directory (Might Directories, 1990), map geography based on Google Maps (Map Data c2018 Google).

Late 1990s to Present: A Shift to the Suburbs

In the 1990s, routes traced by Korean immigrants shifted toward North York. Many community institutions mirrored this shift, leaving Koreatown with little population or community hubs, and therefore no longer meeting the definition of an ethnic enclave. This new route to Canada was again the product of sociopolitical context in both Korea and Canada. South Korea suffered a significant economic recession in 1997, which resulted in an influx of educated and skilled immigrants under the economic class (Kang, 2016, p. 1). Many were also in search of a better education for their children, as the South Korean education system had become extremely competitive due to the country's small resource base and reliance on human capital (Kang, 2016, p. 2). Whereas the first wave of immigrants in the 70s and 80s emigrated to Canada mostly under the family class (Kang, 2016, p. 28), these immigrants under the economic class were able to afford to settle in the suburbs (Kang, 2016, p.1), which helps explain the shift in Korean routes toward North York. Significantly, immigrants were considering the quality of education they could provide for their children, and North York offers good schools (Kang, 2016, p. 44), not to mention more green space compared to the downtown area.

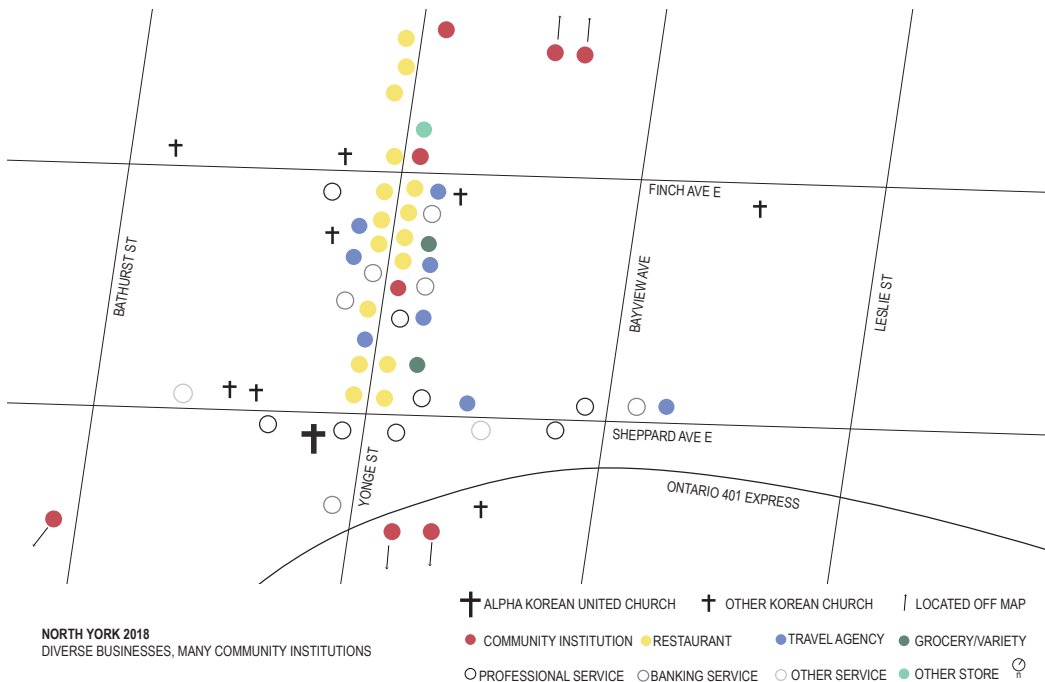


Figure 2 Korean-owned businesses and community institutions currently located in North York. Data and map geography interpreted based on Google Maps (Map Data c2018 Google).

Although various theories exist as to why immigrant routes shift together and enclaves continue to form, likely explanations include a desire for a sense of community (Qadeer et al., 2010, p. 318), as well as barriers faced to employment in Canada that lead to defensive entrepreneurship catered to one's own community (Chan & Fong, 2012, pp. 116-117). Barriers to employment are one reason for which a subset of this second route traced by Korean immigrants in Toronto emerged: that of the *kirogi*, or wild goose, family (Jeong & Belanger, 2012, p. 259). In these cases, the family breadwinner remains in Korea to work, while the rest of the family moves to Toronto to give their children a better education (Jeong & Belanger, 2012, p. 259), often staying in North York (Shin, 2012, p. 186). These are transnational families: one member remains in Korea, transferring capital to Toronto to support the others, who in turn communicate back to Korea and periodically return (Kang, 2016, pp. 19-20). These kinds of families facilitate transnational flows of capital, goods, and people between North York and Korea, supporting the emergence of the ethnic enclave by frequenting Korean businesses, and sending and receiving capital and goods from Korea (Kang, 2016, pp. 19-20). As illustrated in Figure 2, North York is certainly meets the definition of an ethnic enclave, featuring Korean community institutions as well as businesses that cater to Koreans.

As the Korean community shifted toward North York, Koreatown's distribution of community institutions and businesses began to change dramatically. As illustrated in the chart in Figure 3, after immigrant routes shifted toward the end of the 1990s, Koreatown was home to fewer community institutions and services geared toward Koreans, and instead more stores and restaurants. The current iteration of the area is illustrated in Figure 4: where a cluster of Korean community clubs, associations, and services existed in the 1980s (Might Directories, 1983) and 1990s (Might Directories, 1990), there is now a concentration of Korean food and drink establishments, along with a few other shops and ethnic restaurants. In fact, the only community institutions left are the Seniors' Centre at Bloor and Grace streets, perhaps a sign of the last travellers of the original route, and the Korean Journal. The extremely faded sign (Figure 5) of this last institution is unsurprising given the area's population of only 810 ethnic Koreans (City of Toronto, 2018a; City of Toronto, 2018b). Even walking down the street, a shift toward the suburbs is apparent: a flyer is tacked to a closed store front, advertising a suburban location (Figure 6). If an ethnic enclave necessarily comprises businesses, services, and institutions that create a complete micro-community as defined by Qadeer et al. (2010, p. 317), it is clear that Koreatown, with its lack of community institutions and low Korean population, no longer falls under this category.

Branding an Empty Koreatown: Commodification of Korean Identity

Presently, Koreatown retains an observable ethnic identity. Without the community hubs and diverse Korean-owned businesses that comprised the former ethnic enclave, this points to the commodification of Korean cultural identity. In turn, the businesses associated with this commodification reveal the groups of people for whom the neighbourhood now exists. To begin, Koreatown's colourful signage complete with Korean lettering continues to evoke a sense of place rooted in Korean identity, as illustrated in Figure 7. This sense of ethnic identity is reinforced by the neighbourhood's Business Improvement Association (BIA), which state on their website: "Korea Town is the perfect place to taste Korean culture and food. [...] Try Korean BBQs, pork bone soup, and a variety of vegetarian dishes [...]" (Korea Town BIA, n.d.). Here, the words "come try Korean BBQ" (Korea Town BIA, n.d.) demonstrate that the Korean identity attributed to the neighbourhood is being constructed as something specifically geared toward consumption of Korean culture by non-Koreans. According to Terzano (2014), ethnic identity is considered commodified when the area branded with it is void of that ethnic population (p. 344). This is clearly the case here: the BIA

KOREAN-OWNED BUSINESS	1976*	1983**	1990***	2000****	2018*****
Community Institution		••	•••••	••••	••
KOREAN-OWNED BUSINESS	1976*	1983**	1990***	2000****	2018*****
Community Institution		••	•••••	••••	••
Restaurant/Bakery	•	•••	•••••	•••••••	••••••••
Travel Agency	••••	•••••	•••••	•••••••	•••••
Grocery/Variety	••	••••	••••	••••	•••••
Professional Service		••	•••••	••••••	
Banking Service		••	•••••	••••	••
Other Service		••	••	••	••••
Other Store			•••••		••

Figure 3 Change in Koreatown businesses over time. All data has been interpreted based on either Toronto city business directories, Google Maps, or observation, and cannot be completely accurate.

*Based on Might Directories, 1976.

** Based on Might Directories, 1983.

***Based on Might Directories, 1990.

****Based on Polk Multi-Dimensional Intelligence, 2000.

*****Based on data from Google Maps, Map data c2018 Google, as well as personal observation.



Figure 4 Koreatown's current distribution of businesses and community institutions. Data interpreted based on observation and Google Maps (Map data c2018 Google).



Figure 5 Korean Journal sign is faded in upper right hand corner.

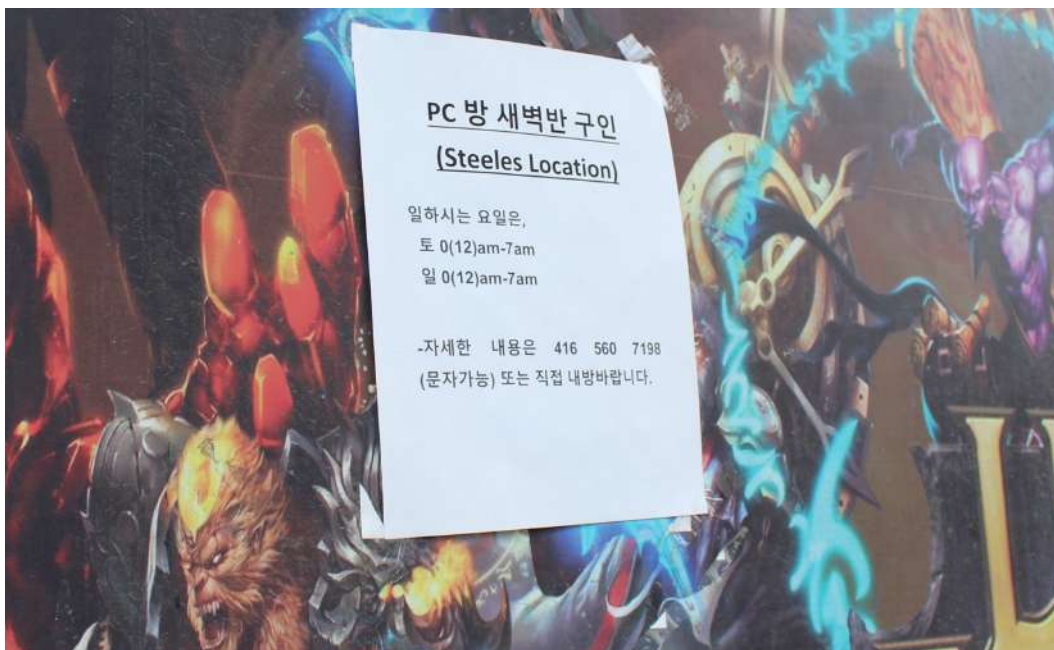


Figure 6 Sign pasted on the front of closed Gigabytes Internet.

is claiming that Korean culture can be consumed in an area that is no longer home to the majority of Toronto's Korean population (City of Toronto, 2018a; City of Toronto, 2018b). Furthermore, the Korea Town BIA website advertises that the neighbourhood's "[...] signature event is the Dano Festival which is held on the first weekend of June at Christie Pits Park" (Korea Town BIA, n.d.). According to Langegger (2016), the use of festivals as tourist destinations is another hallmark of identity commodification (p. 1817). When this happens, cultural practices become performative, rather than for the community itself (Langegger, 2016, pp. 1813-1814). This branding of Koreatown with Korean ethnic identity for consumption begs the question of for whom the area now exists, the answer to which lies in the specific businesses packaged within this neighbourhood brand.

In keeping with their location in a neighbourhood branded with Korean ethnic identity, Koreatown businesses are places in which to consume Korean culture. As laid out in Figure 3, food and drink establishments dominate, and many restaurants in particular offer consumption of Korean culture in the form of food: Arisu Korean BBQ & Sushi at Bloor and Markham streets claims to offer "authentic Korean BBQ[...]" (Arisu Korean BBQ & Sushi, n.d.), Home of Hot Taste boasts its "Korean Style Fried Chicken" on the sign outside, and other stores including the Korean Village Restaurant and Mapo Korean BBQ use Korean identity to sell a dining experience. One restaurant in particular epitomizes the construction of Korean identity for consumption: Barrio Coreano, a Korean-Mexican fusion restaurant with an "intentionally distressed aesthetic" (Ipsum, 2013), offering dishes such as Korean beef tacos and "K-Mex slaw" (Ipsum, 2013). This is a place to consume Korean culture (or someone's idea of it) recreationally – it is not a place for the Korean community itself.

The restaurants outlined above are examples of the kind of consumption of culture that is associated with gentrification, outlined by Shaw (2008) as a process in which the white middle class is attracted to an area for its sense of place, subsequently remaking it according to their own tastes and displacing the original occupants (p. 1698). Ethnic identity can be a part of this sense of place, and its commodification can be a part of the remaking of city space (Langegger, 2016, pp. 1812-1813). In Koreatown, the processes of gentrification taking place are more in line with commercial gentrification, a remaking of the city focused around businesses as opposed to residences (although the two are related) (Shaw, 2008, p. 1706). This is because the sociopolitical contexts behind the shift in routes traced by Korean immigrants through Toronto suggest that Korean residents were likely not displaced.

The process of commercial gentrification in Koreatown is demonstrated effectively through a comparison between two of the restaurants mentioned above, reflecting a remaking of the city to conform to middle-class tastes. First, there is the Korean Village Restaurant, owned by the same Korean family since before immigration routes shifted away from Koreatown (Daubs, 2017). Second, there is Barrio Coreano, which was established more recently by a chain (Ipsum, 2013), and represents a literal remodelling of Korean identity to be infused with elements of Mexican culture. Additional businesses catering to the middle class that have emerged include two upscale tattoo parlours (First Kiss Tattoo and Vintage, Speakeasy Tattoo), two yoga studios, as well as upscale cafes (Rustle & Still, Good Neighbour). There is also street art present in Koreatown (Figure 8), which is another variation of place-making often associated with the process of gentrification (Matthews, 2010, p. 667). Overall, the fact that Koreatown seems to be undergoing these processes of gentrification suggests that the neighbourhood is now an area that caters to the drivers of this process: the middle class.

Although this new middle class is now dominant in Koreatown, there are other groups worth mentioning that continue to frequent the area: Korean consumers, as well as consumers of ethnic products more generally. This presence is demonstrated through the existence of PAT Central, a Korean grocery store chain. PAT Central is known not only for importing products from Korea, but also for creating Korean ethnic food products in-store (Kang, 2016, p. 57). The presence of a store location in Koreatown thus suggests that there is a market for Korean ethnic products in the area (rather than simply Korean cultural experiences), and therefore that Koreans likely frequent the area. However, as opposed to the other two Korean grocery store chains in the Toronto area (Kang, 2016, p. 58), PAT Central store locations are not generally located in concentrated areas of Korean population (Kang, 2016, p. 57), attracting customers of many ethnicities (Kang, 2016, p. 56). This demonstrates that while Koreatown is likely frequented by Korean consumers in some capacity, it is within a context of diverse consumers of ethnic products more generally, rather than as a place to build their community.

An additional factor that is affecting the continued presence of Korean consumers in Koreatown is the neighbourhood's proximity to the University of Toronto. As mentioned previously, part of the reason Koreatown emerged as such is related to an influx of Korean theology students to this school (Brown, 2012). Today, the university still has a significant Korean student presence, complete with a Korean Students' Association (University of Toronto, n.d.). In any case, most of the activity undertaken by Koreans in Koreatown today would be limited to consumption in a neighbourhood remade by the middle class, as the only community institutions left are the Seniors Centre on Grace Street, and the faded Korean Journal.



Figure 7 Collage of some of the signs that mark out different roots in Koreatown, evoking a sense of place.



Figure 8 Street art in Koreatown

Conclusions

Overall, it is clear that since immigrant routes have shifted away from the Koreatown, the area has lost its population and roots in the form of community institutions, keeping only its businesses. Despite this shift in demographic, the neighbourhood's continued branding with and consumption of Korean ethnic identity demonstrate that this identity has been commodified for consumption by the middle class. Koreatown is now a place to not only consume Korean culture in the form of food, but also to sit in an upscale coffee shop or go to a yoga class. Korean immigrants can no longer go there to meet with the Korean Canadian Amateur Sports Association, or take a class at the Korean YMCA.

It is difficult to predict the future of Koreatown. However, the Seniors Centre as one of the last community institutions, coupled with the processes of gentrification taking their course, could hint at a possible end to the neighbourhood altogether. One thing is for certain: the area is changing and will continue to change. Perhaps a third route traced by Korean immigrants through the city will emerge, increasing the complexity of the situation trifold. Such is urban life – the relationship between people and the built environment in which they live is never static.

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Figures

Figure 1 Fraser, Z. (2018). Koreatown 1990. [Digital illustration].

Data interpreted from:

Might Directories (1990). Toronto City Directory Central Ed., pt. 2. 1990. 910.7135.T59. Toronto Reference Library Humanities and Social Sciences Department Reading Room, Toronto, Ontario, Canada;

Map geography based on Google Maps, Imagery c2018 Google.

*Interpretation of data means results cannot be completely accurate, however significant trends are observable.

Figure 2 Fraser, Z. North York 2018. [Digital illustration].

Data interpreted from:

Google Maps, Map Data c2018 Google.

*Interpretation of data means results cannot be completely accurate, however significant trends are observable.

Figure 3 Fraser, Z. Change in Koreatown Businesses Over Time. [Data representation table].

Data interpreted from:

Might Directories (1976). Toronto City Directory 1976 Streets. 910.7135.T59. Toronto Reference Library Humanities and Social Sciences Department Reading Room, Toronto, Ontario, Canada; Might Directories (1983). Metropolitan Toronto City Directory vol. 2. 1983. 910.7135.T59. Toronto Reference Library Humanities and Social Sciences Department Reading Room. Toronto, Ontario, Canada;

Might Directories (1990). Toronto City Directory Central Ed., pt. 2. 910.7135.T59. Toronto Reference Library Humanities and Social Sciences Department Reading Room, Toronto, Ontario, Canada;

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Google Maps, Map data c2018 Google; Personal observation.

*Interpretation of data means results cannot be completely accurate, however significant trends are observable.

Figure 4 Fraser, Z. (2018). 2018 Koreatown. [Illustration].

Data interpreted from:

Google Maps, Map Data c2018 Google; personal observation.

*Interpretation of data means results cannot be completely accurate, however significant trends are observable.

Figure 5 Fraser, Z. (2018). Faded Korean Journal Sign. [Photograph].

Figure 6 Fraser, Z. (2018). Sign Pasted on Closed Store. [Photograph].

Figure 7 Fraser, Z. (2018). Koreatown Signage. [Digital collage].

Figure 8 Fraser, Z. (2018). Street Art in Koreatown. [Photograph].

RELIEF FOR THE FEW, CONGESTION FOR THE MANY: ANALYSIS OF THE PRIVATIZATION OF ONTARIO HIGHWAY 407

By James Chapman

Since the 1980s, governments across North America have increasingly relied upon partnerships with private consortiums to build, maintain, and administer major roadways. In 1999, the Ontario government undertook the largest privatization project in Canadian history, and sold the province's recently constructed Highway 407 to a private consortium for \$3.1 billion. This paper explores the effects of this decision, arguing that the privatization of the highway and the resulting toll increases has meant the highway has: (1) contributed little to relieving regional congestion, and (2) benefited the region's wealthiest residents alone. Using transportation literature and Transportation Tomorrow Survey (TTS) data, the paper then surveys alternative planning strategies which might both relieve regional congestion in the Greater Toronto Area (GTA) and produce more equitable outcomes for all drivers. Specifically, the use of high-occupancy vehicle (HOV) lanes and high-occupancy toll (HOT) lanes are identified as new measures, which if implemented carefully, would relieve congestion for all road users, produce positive environmental outcomes, and allow all drivers access to faster travel times, regardless of income.

Introduction

Since the late 1980s, reliance on private sector partners to build and operate large infrastructure projects has become an increasingly popular policy tool employed by governments in both North America and Europe. Following the ideological imperative of neoliberalism, governments' privatization of public assets and use of public private partnerships assumes that market forces and private corporations will manage both the construction and operation of public utilities more effectively than the public sector (Harvey, 2005). In 1999, the Ontario government undertook the largest privatization project in Canadian history, and sold the province's recently constructed Highway 407 (407; 407 ETR) to a private consortium for \$3.1 billion (Mendoza, 1999). While private management of highways and tolled roads is not uncommon, the extent to which the government withdrew control from the now 108 km highway remains unique within the North American context (Mendoza, 1999). The purpose of this paper serves to explore the effects that the private ownership of the 407 has had on both congestion and regional transportation goals in the Greater Toronto Area (GTA). The paper will propose that the privatization of the 407 in Ontario has done little to relieve congestion in the region and has essentially created a "millionaire's highway" (Mendoza, 1999, p.7). The paper will also argue that the implementation of restricted high-occupancy lanes (HOV lanes) and public toll roads could substantially contribute to reducing automobile congestion in the region, while improving transit equity.

Highway Privatization in North America

The use of private sector partners to fund, construct, and manage transportation systems has become increasingly common across North America since the 1980s. Governments at both the regional and federal level have made it clear they believe that the involvement of the private sector ensures large infrastructure projects are innovative, economical, and constructed quickly. Projects of this nature also fulfill ideological desires for smaller government, lower taxes, and decreased government expenditures by outsourcing costs to private firms (Pochmann, 2003). Broadly, public-private partnerships take two forms. The first, the “design-bid-build model”, employs a private sector contractor for the initial construction - however, after construction is complete, operational control of the project is returned to the state (Siemiatycki, 2009). The second form is closer to complete privatization. The “build-own-operate” model gives a private contractor or consortium complete control over the construction and operation of the utility (Siemiatycki, 2009). It is important to note that in regard to highways, the second model assumes that since the private contractor will be responsible for future maintenance costs, the contractor will make a substantial and adequate investment in the initial construction of the road surface (Engel, Fischer & Galetovic, 2006). Indeed, since contractors are politically isolated, meaning they are not bound by the electorate’s demands, it is often within their rights to freely raise road tolls beyond the rate of inflation, thereby maximizing revenues (Engel et al., 2006).

Despite the potential merits of involving the private sector in the construction and operation of toll highways, numerous ideological and practical concerns have been raised by scholars who examine the effect that this trend has had on service delivery. Many argue that the involvement of the private sector in delivering public infrastructure is anti-labour, as most private contractors often fail to hire unionized workers (Engel et al., 2006). Specifically, in regard to highway privatization, scholars like Engel et al. (2006), have raised concerns that the private sector’s drive for profits can also lead to an uncontrollable rise in toll prices and of safety provisions. Importantly, Siemiatycki (2009) notes that the isolated nature of a private highway and the limited access to information provided to the public by a private consortium limits both the public’s ability to influence company decisions and implement regional transit goals. This said, Winston (2010) argues that some of these concerns can be mitigated by following best practices to ensure tolls are raised moderately. He suggests that governments must ensure that a private toll company is either regulated through a contract, or does not have a monopoly on the project (Winston, 2010). Engel et al. (2006) argue that periodic auctions or temporary leases of highways also gives companies incentives to invest in the safety and maintenance of their roadway to ensure their lease is renewed. In 1995, for example, California began leasing the express toll lanes of Interstate-91 to a private firm for limited periods, ensuring toll prices were reasonable (Siemiatycki, 2009). When bids for control of highways are based on projected toll prices, it ensures that public interest in relation to the highway is preserved. Increasing congestion on major roadways in the majority of North American cities, coupled with political desires to decrease government debt, has resulted in the greater utilization of the build-own-operate model within public-private partnerships in the construction and operation of highways in North America.



Figure 1 Map of the 407 ETR (407 International, 2019).

The Promise and Short-Comings of the 407

Highway 407 in Ontario is a 108km highway which traverses the Greater Toronto Area (See Figure 1). The highway, which has 41 interchanges, 208 overpasses, and 200 tolling gentries, is an open access toll highway, meaning drivers can enter the roadway without stopping at a tollbooth (Residential and Civil Construction Alliance of Ontario [RCCAO], 2014). Drivers pass under gentries which identify vehicles, their size, and the length of their trip by scanning for a transponder or taking a picture of their licence plate. Bills are then mailed to drivers on a monthly basis. The original 9 km highway, built in 1987, ran directly parallel to Highway 401 – one of the busiest highways in the world (Mendoza, 1999). In 1989, the provincial government adopted a build-operate-transfer agreement with the Canadian Highways International Corporation to build another 36 km extension of the highway. The purpose of the extension was to continue to relieve congestion on the 401, advertise Ontario's attention to innovation, and encourage development outside of the City of Toronto (RCCAO, 2014).

Following the opening of the highway in 1997, a change in provincial government would drastically transform the future trajectory of the 407. In 1995, the Progressive Conservative Party, led by Mike Harris, defeated the left-of-centre New Democratic Party to form a majority government in Ontario. Elected on a neoliberal platform, nicknamed the “Common Sense Revolution,” the new government quickly moved to lower taxes, reduce government spending, and privatize numerous public assets. However, under substantial criticism for undercutting hospital budgets and failing to deliver on an election promise to reduce the provincial deficit, by 1998, it was unclear how the Harris government would fare in the upcoming provincial election (Ibbitson, 2000). Selling the 407 for a considerable profit however, would allow the government to undo its fiscal cuts to hospitals, while reducing the provincial deficit, thereby improving its probability of forming a government again in the process (RCCAO, 2014). Mendoza (1999) notes that two options were considered by the provincial cabinet to raise revenues from the sale of the 407. The first, was to create a public-private partnership with a private company to manage the toll road on the government’s behalf. This option would raise tolls to continuously finance the provincial deficit and to maintain the highway itself. The second option considered, was a complete one-time, full-equity sale of the highway, which would divest the 407 to a private consortium. Unfortunately, since the profitability of the 407 was unproven, as its tolling technology was untested, and its greenfield location made

demand uncertain, the government was challenged to find a company willing to submit to government regulations while taking a share of the 407's financial risks (Mendoza, 1999). Therefore, with an eye on the quickly approaching provincial election, the Harris government opted to sell the toll road with minimal regulation, besides a commitment from the buyer to comply with MTO regulations and raise tolls by no more than 2% plus inflation from the then-current 11 cent per km toll schedule (Mendoza, 1999). Importantly, in making the sale as appealing as possible, the private owner would not have to seek approval from the province to raise tolls, but would have to pay the province a fee if it failed to reach certain congestion targets (Mendoza, 1999). In 1999 the government successfully sold the highway for \$3.1 billion to 407 International, a consortium led by a Spanish firm and two Quebec companies (Mendoza, 1999).

The privatization of the highway was quickly seen by many as a success. Ibrahim and Gorys (2008) argue that with the population of the GTA expected to grow by 2.5 million over the next 25 years, (increasing commute times by 45%), the highway's increasing tolls were necessary to reduce congestion. The privatization of the highway, they argue, also ensured that the length of the road was expanded, the physical standards of the road were maintained, and that the number of lanes increased, without any cost to the province (Ibrahim et al., 2008). Proponents also point to the fact that the number of daily users of the highway have almost doubled since it was transferred to the consortium. In 1999, 237 000 trips were made on the 407 on an average day, with 408 000 trips per day made by 2017 (407 International, 2017a).

Despite this apparent success, soon after the deal between the Ontario government and the consortium was signed, criticism mounted from progressive activists, journalists, and the Ontario Truckers Association. The Residential and Civil Construction Alliance of Ontario (RCCAO) (2014), for example, argues that the fact that the government negotiated the deal in private, meant that no attention to good governance had been taken. The profitability of the deal has also come into question. While the \$3.1 billion sale looked impressive as it doubled the initial \$1.5 billion cost to build the highway, estimates suggest the highway should have been valued at closer to \$12 billion (Cohn, 2015). In 1999, a 6% share of the 407 International consortium was priced at \$45 million, but by 2002, the same share was worth four times that (Cohn, 2015), leading to suggestions that the Progressive Conservatives' sale of the highway was indeed a politically motivated "fire sale" (Erwin, 2006).

Ideologically, many journalists have argued that if the highway had remained in public ownership, tolls would have been raised marginally and reincorporated into the province's infrastructure fund. The Ontario Trucker's Association (OTA) has called the highway a "monster in our midst" because of the rapid increase in tolls that the company has imposed (Smylis, 2004, p. 1). While tolls were 11 cents per kilometer when the consortium took control of the highway in 1999, they are now 30 cents per kilometer, representing a 300% increase—well above the 30% plus inflation rate that the province had originally negotiated (Cohn, 2015). Court cases launched against the consortium to reduce these costs have failed, as in the Harris government's haste to sell the highway, 407 International Inc. was not bound to certify increases with the government (Erwin, 2006). In 2017, the average trip on the highway cost \$9.96, up \$1 from the year prior (407 International, 2018). To make matters worse, despite the fact proponents have noted the substantial investment that the company has made in expanding and improving the highway, in 2017, the 407 International posted a \$470 million profit, which would serve as another substantial increase from its 2016 profits of \$372 million (407 International, 2018).

While criticism launched against the sell-off of the 407 has been widespread, in regards to transportation planning, the minimal effect that the private toll road has had on both congestion relief and transportation equity in the GTA should be concerning to transportation planners. One of the primary goals for the original construction of the 407 was to relieve congestion on the 401, as at the time it was one of the busiest highways in North America. A Toronto Star article from 1995 argued that the 407 would be “very attractive” to those sitting in congestion on other 400 series highways within the region (Dutton, 1995). The highway was also supposed to induce affordability in the Greater Toronto Area (GTA). In theory, since the highway would allow for more efficient commutes to the city’s core, residents working in Toronto could live further from the core, where the housing market tends to be more affordable, and still commute to the city in an efficient manner (Dutton, 1995). Yet, evidence suggests that since the privatization of the 407, the highway has had little effect on relieving congestion on parallel routes or inducing affordability.

The 407 International boasts that the 124 million trips made on the highway each year are evidence of the 407’s role in removing vehicles from other roadways (407 International, 2018). This said, congestion on parallel roadways has failed to improve since the 407 was privatized in 1999. In fact, traffic on the parallel 401 has steadily increased (Ontario Ministry of Transportation, 2016). Although traffic on the 401 has largely increased as a result of population growth in the GTA, little evidence suggests that the 407 has contributed to mitigating congestion on the busy highway at all. Bottlenecks are defined as severe traffic choke points in which demand exceeds the availability of road space, resulting in increased travel times (Canadian Automobile Association [CAA], 2017). Congestion of this nature not only cuts into urban residents’ productive hours and personal time, but also increases pollution and fuel costs (CAA, 2017). The worst bottleneck in Canada is from Yonge Street to the Highway 427 on the Highway 401 (CAA, 2017). Congestion in this area is estimated to cost the city’s local economy \$82 million a year, and add some 15, 250 kg of carbon pollution to the atmosphere (CAA, 2017). Interestingly, this 15 km route runs directly parallel to the 407. In fact, the Canadian Automobile Association (2017) suggests that while congestion times in Toronto rank only behind New York, Chicago, and Los Angeles in North America in its severity, the 407 is notably absent of any congestion. This suggests that the 407 is doing little to relieve congestion for the broader region within the GTA. Figure 2 and Figure 3 illustrate congestion across the GTA during peak travel times in both the morning and evening. While the 401 is severely congested, the data recorded in Figure 2 and 3 suggest that the 407’s 400 000 daily drivers, account for only a small share of the number of drivers traveling through the corridor daily, suggesting the burden of congestion is not evenly shared between the two highways.

The OTA notes specifically that the huge costs imposed on drivers using the 407 keeps many trucks on already congested routes (Smylis, 2004). Newspaper articles also suggest that many private drivers are unwilling to pay the 407’s exorbitant tolls in order to leave the 401 for the private highway (McGran, 2003; Ibbitson, 2000; Cohn, 2015). This said, the 407 argues that it has “...become a mobility solution for those crossing the GTA and avoiding congestion elsewhere” (407 International, 2017b). A public survey of 407 users suggests that 60% of drivers say use of the toll road reduces their commute by 20-30 minutes, and greatly decreases their environmental impact and fuel costs (407 International, 2017b). It seems those who use the 407 value its service – its ability to reduce fuel costs, and improve predictably and safety are something 407 users are willing to pay for, as the highway has notably less accidents in comparison to similar routes because of the reduced number of trucks that travel on it. (407 International, 2018). Yet, the highway’s limited number of users and limited impact on regional congestion suggests that while the highway addresses the needs of its customers, it does not consider the needs of all motorists in the GTA (RCCAO, 2014). Who

are the customers who the 407 International address? An analysis of the 2016 Transportation Tomorrow Survey (TTS) suggests that the vast majority of 407 users make over \$125,000 a year (See Figure 4). It appears therefore, that the highway has become what the Harris government promised their liberal toll regulation regime would prevent—"a highway for millionaires" (Mendoza, 1999).

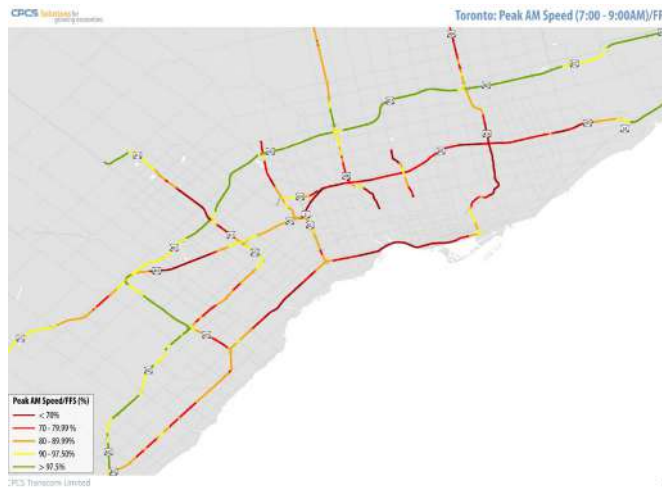


Figure 2 GTA Travel Times during Peak Morning Rush-Hour; Notice the absence of congestion on the 407 (CAA, 2017).

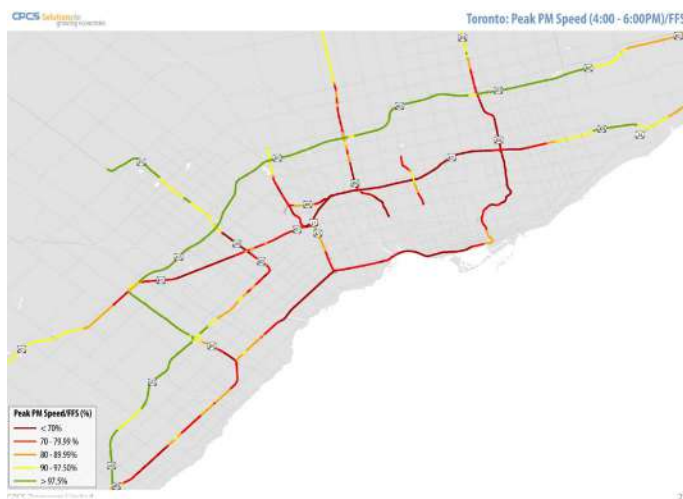


Figure 3 GTA Travel Times during Peak Evening Rush-Hour; Notice the absence of congestion on the 407 (CAA, 2017).

Lessons from the Privatization of the 407

My analysis of the impact of the Highway 407 in the GTA suggests that the privatization of toll highways can be detrimental to regional transportation goals that seek to relieve congestion. I have argued that the profit motive of the 407 International has increased tolls so substantially that the highway now fails to divert drivers from congested parallel routes like the Highway 401, unless a driver makes more than \$125,000 annually. This said, the 407 International is not wrong when it states, “tolls ensure we control traffic congestion” (407 International, 2017b). Numerous studies from across North America support this assertion, with an important exception: tolls can decrease congestion, but only when they are run by honest brokers and not a profiteer (Cohn, 2015). Winston (2010) argues that driving, unlike the use of public transportation, is largely composed of private costs, such as vehicle maintenance, fuel costs, and time lost to congestion. However, he also proposes that driving induces a large social cost, as each driver is also adding volume to congestion, reducing others’ speeds (Winston, 2010). When tolls are implemented in the public interest, this social cost is recuperated by charging each driver for their contribution to the costs of other users (Winston, 2010). The private operation of toll roads, although meant to recuperate social costs, often results in an increase in tolls beyond a marginal cost, decreasing drivers’ welfare in turn (Swan & Belzer, 2010). For example, in Ohio, a study by Swan et al. (2010) suggested that even small increases in tolls diverted trucks away from private toll roads back to public roads, where accidents occurred more frequently as a result of an increased volume of trucks. In the case of the 407, the private consortium has raised tolls to a degree that only those who can afford to pay for the use of the highway benefit from the congestion relief provided on the private roadway itself. Conversely, Hurtado (2009) argues that publicly managed toll roads have an inclination to ensure what is best for the region. As a result, tolls set by public authorities are generally kept low enough to attract a significant number of drivers away from congested routes, ensuring the burden of demand is evenly shared across all roadways in the region (Hurtado, 2009). As early as 1924, economist Knight argued that a public toll road would set an optimal congestion toll if faced with competition from an alternative free road (Winston, 2010). Indeed, public control of the 407 may have potentially assisted in making the highway an attractive alternative to those traversing the GTA and not making \$125 000 annually. Therefore, tolls must be established not based on profit margins, but based on what the average user is willing to pay to divert from congested routes, use public transit, or modify their schedules.

An additional best practice unrealized when the 407 was privatized in 1999, was the ability to recuperate drivers’ social costs into public infrastructure funds. Chen and Yang (2012) argue that publicly tolled roadways reinvest revenue from tolls back into system-wide road maintenance, public transit systems, bike networks, and green cars. While the 407 International argues it has reinvested \$163.9 million of toll revenue back into the highway in the form of road expansion and maintenance in 2017 alone (407 International, 2018), these expenses continue to only benefit those who have the privilege to use the road. The company also posted an additional \$470 million income in 2017 (407 International, 2018), money which could have been reinvested into region wide transportation, (a \$130 billion plus expenditure in Ontario currently, Benzie, 2015). While the initial \$3.1 billion sale of the highway was an impressive pay day in 1999, if the government of Ontario had recuperated tolling revenues at the same rate that the 407 International does currently, the government would have made much more than that amount by now.

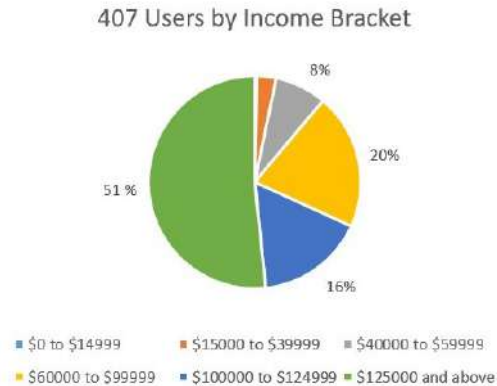


Figure 4 407 Users by Income Bracket (Transportation Tomorrow Survey, 2016).

Improving Transportation Networks in the GTA

Unfortunately, the length and terms of the 407 International's contract with the Ontario government ensures that the public will continue to have little control over the roadway, and the cost of tolls to use the highway will continue to remain high. Numerous court cases launched by the Ontario government against the 407 International in the early 2000s meant the effort to lower toll prices in order to match regional transportation goals had failed (Erwin, 2006). The government's re-purchase of the 407 also seems unlikely, as it involves the complex and often subjective process of predicting the future value of the highway (Siemiatycki, 2009). As a result, attempts to improve transportation networks in the GTA must assume the 407 Express Toll Road (ETR) will continue to remain in the control of the private sector and operate as it does currently. Lessons learned from the effects that the privatization of the 407 has had on regional transportation however, does supply important advice for future planning.

High-Occupancy Vehicle (HOV) lanes are highway lanes designated for certain types of vehicles, like buses and taxis, and private cars often carrying two or more people. Since 1985, when they were first introduced in California, more than 2 500 miles of HOV lanes have been built in the United States alone (Shewake, 2012). In Ontario, small portions of the 400-series highways and the Queen Elizabeth Way (QEW) include lanes on the far-left shoulder, which have been designated for high occupancy vehicles (Ministry of Transportation, 2013). In Ontario, penalty for misuse of the lanes is \$110 and 3 demerit points (Ministry of Transportation, 2013). Proponents of HOV lanes argue that their introduction reduces commute times for those willing to organize a car pool, encouraging others to participate in the environmentally friendly behaviour in order to benefit from the increased mobility (Shewmake, 2012). Those who benefit from the increased mobility of HOV lanes are not limited to the few who can afford to pay exorbitant tolls to avoid congestion, but those who take the time to organize a car pool – a practice which directly reduces the social cost imposed by drivers on the environment. Beyond the arguments around equity and environmental concerns, studies have shown that HOV lanes in the GTA have been effective in reducing congestion. On Highway 427, located just east of Toronto, HOV lanes were found to reduce travel times by 9 minutes for users, while carrying sometimes over 900 vehicles per hour, well over the 500 vehicle minimum standard (Nikolic & Pringle, 2008). In this way, increasing the number of HOV lanes in the GTA could offer a feasible solution to reducing congestion and increasing transportation equity.

That said, the success of HOV lanes is not universal, nor are their minimum impacts likely to vastly decrease congestion in the GTA. Shewmake (2012) argues that HOV lanes may actually increase costs for drivers, as although users benefit from saving fuel costs and travel time, costs are raised through the loss of flexibility and the time needed to join a carpool. 2016 Transportation Tomorrow Survey data also suggests that fewer trips made in the GTA involved a car pool between 2011 and 2016 (University of Toronto, Department of Engineering, 2011, 2016). As a result, the introduction of modestly priced, publicly managed tolls may have a more aggressive impact on congestion in the GTA. Amborski (2017) argues that tolls charged based on time of day, distance travelled, type of vehicle, and road traffic congestion, could both reduce congestion and help pay for transit improvements in the region. Proponents argue that new road tolls would force drivers to pay for the social costs created by driving (Haines & Burda, 2017). Additionally, successful road pricing schemes in cities like Stockholm have diverted drivers to different modes of transit and times of day in which to travel, reducing congestion by upwards of 20% (Haines et al., 2017).

The implementation of road tolls is likely to be politically unpopular, however. In 2016 Mayor John Tory's proposal to toll highways in and out of Toronto was met with 46% support from Toronto voters (Spurr, 2016). Some of this criticism of the policy was perhaps due. Many saw Tory's plan as a "tax on the 905," (Spurr, 2016) as those privileged enough to live in the downtown core could almost entirely avoid paying tolls, while those in the city's transit-starved suburbs would be forced to pay. Yet, as Winston (2010) notes in the case of New York City, as the public becomes increasingly aware of the need for transit funding and congestion relief, new methods like tolling will become increasingly popular politically. Therefore, numerous efforts must also be taken to offset the disproportionate impact road tolls will have on auto-dependant drivers. As emphasized by the case of the 407, any new toll roads must remain in public hands, as due to political, rather than market pressures, tolls are less likely to rise beyond the rate of inflation (Hurtado, 2009). Additionally, regional planning agencies must explore policy options to ensure the revenue raised through tolls directly benefits communities which have a higher frequency of paying for them. Chen et al. (2012) note that this can be done through a two-stage charge, where users pay tolls and then are rebated via direct payment if they qualify as low-income, or with investment in alternative forms of transportation situated to benefit their community specifically.

Conclusion

This paper has proposed that while both federal and regional governments in North America continue to utilize privatization and public-private partnerships to operate toll highways, Highway 407 in Ontario highlights a number of planning deficiencies which arise from this practice. Since the Highway 407 was privatized in 1999, the profit motive of the 407 International has substantially increased tolls to the point that the highway now fails to divert drivers from congested parallel routes like the Highway 401. This has created a situation in which the majority of drivers in the region are forced onto congested public roadways, while the privileged few who can afford the 407 International's high toll rates effectively avoid the costs of congestion. Therefore, as the GTA attempts to decrease congestion and expand transportation equity, new public toll road and HOV lanes should be explored by policy makers, rather than private highways. This said, additional research into the travel patterns of GTA residents must be completed first. While this report has noted that Highway 407 drivers are primarily among the highest income earners in the region, these high incomes are reflective of the area directly surrounding the highway. Additionally, open data from the consortium managing the 407 could provide additional chances for planners to examine the effect of the highway on regional transportation and equity.

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THE GOAL OF SOCIAL DIVERSITY IN NEW URBANIST DEVELOPMENTS IN THE GTA

By Rebecca Tom

New Urbanism is a design movement that aims to accommodate a range of income levels, ethnicities, and ages through the construction of various dwelling types in neighbourhoods. However, the goal of social diversity has been contested as New Urbanist neighbourhoods are criticized for remaining exclusive, affluent middle-class spaces. This paper utilizes 2016 Canadian census data to compare two New Urbanist developments, Cornell, Markham and Greenway, Toronto, to adjacent neighbourhoods in these respective regions. The census data demonstrates a contradiction between New Urbanist theory and practice as these neighbourhoods do not possess a significantly different social composition relative to the surrounding area. These two case studies reveal that neo-traditional physical design, which remains an expensive form of architecture that developers continue to exploit, is not an effective solution to prevalent societal problems, contrary to what New Urbanists promised and the municipal government anticipated.

Introduction

Continually labelled as one of the world's most multicultural cities, Toronto is faced with the challenge of addressing the housing needs of a growing and diverse population (Grant & Perrott, 2008). New Urbanism, a neo-traditional design movement that emerged in the late 1980s, has been received positively by the municipal government as it promises to transform the segmented urban landscape and social segregation created by conventional modernist planning. The design movement encourages neighbourhood diversity by providing an adequate range of housing types, social services, and institutions for its population (Grant & Bohdanow, 2008). However, this principle of building various dwelling types in which a range of income levels, ethnicities, and age groups will follow has been challenged as New Urbanist developments are criticized for remaining exclusive, affluent middle-class spaces (Day, 2003). This research paper will focus on two New Urbanist developments, Cornell in Markham and Greenway in Toronto. Using census data, it will analyze whether the New Urbanist neighbourhoods are significantly more diverse than adjacent neighbourhoods in the region. The results show that there is a discrepancy between New Urbanist theoretical rhetoric and the reality of implementation. These two areas under study are similar in economic and ethnic demographics: both are fairly homogenous to their adjacent neighbourhoods. New Urbanist designed neighbourhoods certainly illustrate a change in the development pattern aiming to reduce sprawl and expand the available dwelling options; however, this physical mix has not translated into the social diversity that the municipal government had envisioned.

From Modernism to New Urbanism

The population boom experienced in the 1950s left cities worldwide struggling to meet the housing demand from an unprecedented number of young families. At the time, North American cities viewed suburban growth as the most viable and cost-efficient solution to deliver a large supply of housing. Thus, a prevailing suburban development pattern characterized by sprawling, low-density housing in segregated developments was produced (Bourne, 2008). This development pattern soon became unsustainable as road congestion, unserviceable mono-functional areas, and wealth polarization between the inner-city and outer suburbs intensified (Sorensen, 2011).

New Urbanism emerged when city officials were desperate to manage the extent of this urban sprawl. Supporters of New Urbanism rejected the ruling modernist development pattern and instead emphasized diversity, connectivity and human-scale development (Grant & Bohdanow, 2008). New Urbanism aimed to produce the social diversity that developed organically and incrementally in the inner-city, through physical neighbourhood changes. The movement has manifested as a global design ideology applied by planners and developers. In Toronto, New Urbanism is a localized housing response that encourages mixed-use development and more “responsible” building practices (Moore, 2010, p. 103).

Goal of Social Diversity

In 2001, The Congress of the New Urbanism published a charter which outlines 27 principles that are intended to guide design and development practice. Principle 13 states: “Within neighbourhoods, a broad range of housing types and price levels can bring people of diverse ages, races, and incomes into daily interaction, strengthening the personal and civic bonds essential to an authentic community” (Congress of the New Urbanism, 2001). This principle assumes that by improving the range of housing in these developments, a diverse population will follow that differs from the socially homogenous populations that characterize post-World War II neighbourhoods.

The agenda of diversity in many large Canadian cities, such as Toronto, is encouraged by multiple levels of governments based on the notion that this social mix will contribute to economic vitality and social justice (Grant & Perrott, 2008). Johnson and Talen (2010) make a supporting claim that social mixing is essential for creativity, tolerance, and human exchange within neighbourhoods. New Urbanism is not unfamiliar to city officials as Grant and Bohdanow (2008) contend that Toronto has actively promoted design qualities, such as infill development, intensification, and smart growth since the early 1970s. Furthermore, the City of Toronto’s government has published a regional Places to Grow Act which adopts New Urbanist planning principles, advocating for complete communities which “accommodate people of all stages of life and have the right mix of housing” (Ministry of Municipal Affairs and Housing, 2017, p. 18).

Several developments in the GTA incorporate New Urbanist design principles. The degree of implementation of principles varies between development projects and is largely dependent on the incentives and motivations of the developer. Day (2003), for example, has specified that increasing diversity in the suburban setting is often achieved by providing dwelling types that will accommodate low-income populations, such as stacked townhomes and accessory apartment units. Yet, despite diversity being promoted as a key element of success in good New Urbanist design, there is no clear consensus among project developers on how to accomplish this principle or mandate for affordable housing in their design, rather they are weakly guided by the widespread theoretical promotion of the idea.

Case Study Analysis

Statistics Canada's (2017) 2016 Canadian Census data will be utilized to compare the dwelling types, income diversity, and ethnic diversity in the two New Urbanist neighbourhoods chosen for the case study analysis.

Cornell, Markham

The neighbourhood of Cornell, located in Markham, is the largest New Urbanist development in Canada which makes it a strong case for analysis (Moore, 2010). Cornell was conceptualized as a master-planned suburb designed by the company of one of the principal founders of New Urbanism, Andres Duany, in 1992 (Moore, 2010). Self-proclaimed as "Canada's Centre of Excellence for New Urbanism" (Moore, 2010), Markham was one of the first cities in the GTA to adopt New Urbanist principles. The city's adoption of New Urbanist design is evident in their current 2014 Official Plan which outlines the goal of diversifying their housing stock to accommodate "smaller households, senior-led households, immigrant households and lone-parent households" (Markham Official Plan, 2014, p. 4). Markham has linked this policy of diverse housing to an inclusionary strategy for their large visible minority population and to an approach that would spread this cultural wealth throughout the city. There is a balanced range of dwelling types in the Cornell aggregate dissemination area which is composed of 35% single-detached dwellings, 36% row houses, 20% semi-detached dwellings and 9% apartments (Statistics Canada, 2017a).

When you compare the housing diversity and social demographics of Cornell to the neighbouring developments Greensborough and Mount Joy, a similar social demographic between the three areas emerges (see Appendix A). Greensborough is a hybrid New Urbanist development located on the west side of the Ninth Line boundary separating the neighbourhood from Cornell. Greensborough is considered a hybrid design because most of the properties possess paved driveways leading to a front facing garage, inhibiting pedestrian sidewalks on both sides of the street which is common in New Urbanist design (Grant & Bohdanow, 2008). Mount Joy is a traditional suburban development located south-west of Cornell which consists of low-rise and low-density modernist-style housing. Both Greensborough and Mount Joy contain a predominant supply of single detached housing at 72% and 90% respectively (Statistics Canada, 2017a, 2017b).

Despite Cornell possessing a greater diversity of dwelling types, when compared to Greensborough and Mount Joy, the three aggregate dissemination areas all contain similar ethno-cultural and income demographics. The City of Markham has a large Asian ethno-cultural composition which is certainly reflected in both Greensborough's and Cornell's ethno-cultural composition (Grant and Perrott, 2008). Interestingly, Mount Joy appears to have a greater diversity of ethno-cultural representation compared to the other two neighbourhoods, despite containing the least amount of physical dwelling mix. Moreover, the income distribution patterns of all three developments are quite similar, all possessing a household median income of over \$100,000 (Statistics Canada, 2017a; Statistics Canada, 2017b). These results counter the notion that social diversity will follow greater dwelling mix in New Urbanist theory.

Greenway, Toronto

The Greenway development is in The Beaches, an eastern Toronto inner-city neighbourhood that is further divided into four smaller districts that each surround a beach off of Lake Ontario. The development will be compared to two other dissemination areas, one in Kew Beach and the other in Balmy Beach (see Appendix B). This comparison will be a unique example of social diversity as Toronto's inner-city typically consists of a range of dwelling types due to incremental development. As a waterfront heritage and entertainment district, The Beaches is known for its wealthy, largely European Canadian community (Moore, 2010). Thus, despite each of these dissemination areas containing a range of dwelling types, Greenway can illustrate whether New Urbanist design has a considerable impact on income and ethnic diversity compared to the established uniform demographic of The Beaches.

The Greenway development is a mid-1990s, 36-hectare urban infill development on a brownfield site (Moore, 2010). The large lot size is uncharacteristic of infill development considering the valuable inner-city land the development is situated upon, making this site a unique case of analysis. Although Greenway is not marketed as a New Urbanist development, the neighbourhood possesses key New Urbanist design features, including multiple pedestrian pathways, a grid-street pattern, and detached garages accessible by the rear laneway of a dwelling (Moore, 2010). While the developer has claimed to have designed Greenway to have a mix of dwelling types to increase the affordability for diverse income populations, Moore (2010) argues this housing density and diversity strategy was also motivated by the developer seeking to attain the greatest profit from desirable lakefront views and capitalizing on the wider Beaches neighbourhood's affluence. The dissemination area census data for Greenway indicates that the development contains a balanced proportion of single-detached dwellings (36%), low-rise apartments (34%), semi-detached dwellings (22%), and row houses (8%) (Statistics Canada, 2017c).

Utilizing income and ethnic demographic census data of Greenway, Kew Beach and Balmy Beach dissemination areas, a similar social background is revealed. The highest individual median income measured (after tax was removed) was in Greenway at \$49,776, although each of the areas contain a median income higher than the citywide median, which may indicate a lack of affordability (Statistics Canada, 2017c). Moreover, the income distribution remains quite similar between each of these regions. It does not appear that the New Urbanist design has successfully fostered a substantially different income composition from the wealthy populations of Kew Beach and Balmy Beach. All three dissemination areas contain a larger proportion of European ethnicities than any other ethnic groups, which is comparable to the ethno-cultural pattern found in The Beaches aggregate census data (Statistics Canada, 2017c; Statistics Canada, 2017d).

Interpretation of Results

Grant and Bohdanow (2008) conducted a survey of 42 New Urbanist developments across Canada and their results are congruous to the empirical data from both case studies of this research paper. Their findings indicated that most New Urbanist neighbourhoods successfully implement a physical mix of housing at the project level but there is little evidence to support the idea that these neighbourhoods are more affordable or contain a significantly different socio-cultural population when compared to their traditionally developed counterparts (Grant & Bohdanow, 2008).

The limited social diversity evident in both the suburban and urban contexts indicates that physical design is not an effective solution to prevalent societal problems contrary to what New Urbanists have promised and municipal governments have anticipated. Day (2003) states that supporters of New Urbanism optimistically presume that they can solve unaffordability, automobile dependence, and ethnic segregation in neighbourhoods by physically designing an “aesthetically good” community. But one of the largest criticisms of New Urbanism remains evident, design principles are limited in their influence and are unlikely to address societal barriers (Day, 2003). While Cornell has implemented innovative affordable dwelling types, the proportion of these options do not offset the higher costs of the other dwelling types that are built for a wealthier income group (Grant & Bohdanow, 2008). Furthermore, societal barriers such as inflated housing market values inhibit many groups from moving into Cornell. It becomes clear that New Urbanist neighbourhood design overlooks underlying social group differences that are structurally perpetuated.

While both New Urbanist development case studies contain a diverse range of housing, the architecture imitative of early 20th-century form remains a novelty for developers to exploit. New Urbanist developments possess a high profit potential as neo-traditional design is valued among consumers. But New Urbanist design also requires extensive planning on the developer’s part as multiple dwelling types must be configured into one plan, compared to the typical monofunctional suburban development scheme. Furthermore, higher building costs are involved when additional rear laneways and ornamentation constitute the architectural design (Steffel, Johnson & Talen, 2008). Although New Urbanist neighbourhoods strive to produce a range of dwelling types for a multitude of income levels, these premium costs associated with building neo-traditional architecture and street morphology offset much of the potential affordability (Steffel, Johnson & Talen, 2008).

The unchanged social demographic of Cornell and Greenway from their corresponding surrounding region suggests that these developments were marketed towards middle-class families which is consistent with typical suburban development projects. New Urbanist projects sell well in both the city and suburbs as homeowners are willing to pay more for the idyllic neighbourhood conceptualized and marketed by developers (Moore, 2010). Both Cornell and Greenway have stated their intentions to build a community that contains a multi-ethnic population of various income levels, and yet, only certain social groups can afford the cost of living in these high-quality designed neighbourhoods (Day, 2003). New Urbanist developments can be built with good intentions, but affluent middle-class families are often the sole consumers to whom these developments are targeted, a group that is already largely represented in adjacent residential neighbourhoods.

Grant (2006) contends that New Urbanism is a “suburbanized image of what the city should be” (p. 165) and has created enclaves of affluent homeowners seeking the nostalgia of traditional architecture but with the modern amenities an urban environment would provide. New Urbanist developments intend to produce an aesthetically-harmonious community through top-down orderly design. But Day (2003) argues that there is a difference between this deliberate, master planning for diversity in New Urbanist developments and the organically developed social diversity associated with urban environments. Multi-ethnic demography in the city occurs incrementally in reaction to macro changes in immigration trends, employment rates and free market real estate dynamics (Day, 2003). While the prescribed arrangement of mix in New Urbanist communities is neither good nor bad, design that intentionally removes the “chaotic medley” of processes that contribute to diverse urban environments cannot be duplicated in an idealized, aesthetically-driven suburbia (Grant, 2006).

Conclusion

New Urbanism is a compelling design strategy that claims to counter urban sprawl with density, increase affordability through a range of dwelling types, and improve connectivity through pedestrian-oriented streetscapes (Charter of the New Urbanism, 2001). The approach has been encouraged by governments as problems of sprawl, affordability and connectivity have been exacerbated by the modernist suburban development of the previous century. However, New Urbanism appears to be incapable of meeting its anticipated merits as many developments can only achieve half the intentions of Principle 13 (Grant & Bohdanow, 2008). Based on the analysis of two New Urbanist designed developments, it has been demonstrated that Cornell and Greenway have provided a range of dwelling options that is uncharacteristic of typical residential developments. According to the Charter of the New Urbanism (2001), this diversity should mean greater accessibility to housing in the neighbourhood, producing a balanced proportion of ages, incomes, and ethnic groups. However, the census data has demonstrated an opposite inclination, as these neighbourhoods do not possess a significantly different social composition relative to adjacent neighbourhoods. The contradictions between theory and practice are evident in these two case studies. While New Urbanism contributes to providing more housing options and encouraging humanist-scale neighbourhood design, we cannot assume that by changing the physical structures in a space, the latter component of social diversity outlined in principle 13 will necessarily follow.

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Appendix A 2016 Canadian Census Data of Greensborough, Cornell, Mount Joy Aggregate
Dissemination Areas and Markham Census Subdivision

	Greensborough	Cornell	Mount Joy	Markham
Aggregate Dissemination Area (ADA) Number	35290039	35190044	35190046	Census Subdivision
Population of ADA	9,490	10,048	8,872	328,966
Income Composition				
Median total income of private households in 2015 (before tax removed)	\$110,569	\$103,607	\$120,149	\$89,028
Below \$10, 000	19.4%	17.7%	20.4%	20.8%
\$10, 000 - \$19, 000	18.1%	14.3%	13.6%	20.2%
\$20, 000 - \$29, 000	12.3%	10.9%	10.4%	13.5%
\$30, 000 - \$39, 000	10.1%	11.8%	11.3%	10.7%
\$40, 000 - \$49, 000	10.1%	11.1%	10.6%	8.9%
\$50, 000 - \$59, 000	8.0%	8.6%	8.2%	6.9%
\$60, 000 - \$69, 000	6.2%	7.5%	7.2%	5.2%
\$70, 000 - \$79, 000	5.5%	6.0%	5.7%	4.3%
\$80, 0000 and over	10.3%	12.3%	11.8%	9.6%
Private Dwelling Composition				
Private Dwelling Composition	2,590	3,030	2,820	88,905
Single-detached house	72.0%	34.7%	90.1%	68.5%
Semi-detached house	10.6%	20.1%	1.2%	7.3%
Row House	17.0%	36.1%	4.1%	15.7%
Apartment or flat in a duplex	0.4%	5.6%	4.1%	6.6%
Apartment in a building that has fewer than five stories	0.0%	3.5%	0.9%	1.9%
Ethnic Composition				
Total – Ethnic origin for the population in private households – 25% sample data	9,485	9,605	8,875	327,400
North American origins	4.59%	12.6%	15.2%	6.8%
European Origins	16.29%	33.9%	54.5%	22.2%
Caribbean Origins	4.59%	4.2%	6.0%	3.3%
Latin, Central and South American Origins	1.58%	3.0%	1.1%	1.6%
African Origins	2.69%	3.3%	2.4%	2.3%
Asian Origins	80.02%	61.8%	39.6%	73.9%
Oceanic origins	0.0%	0.0%	0.2%	0.1%

Appendix B 2016 Canadian Census Data of Greenway, Balmy Beach, Kew Beach Dissemination Areas and The Beaches Aggregate Dissemination Area

	Greenway	Balmy Beach	Kew Beach	The Beaches
Aggregate Dissemination Area (ADA)	35204752	35203233	35200665	35200218
Population of ADA	726	642	847	7,589
Income Composition				
Median total income of private households in 2015 (before tax)	\$59,776	\$42,283	\$46,848	\$44,808
Below \$10, 000	10.4%	15.1%	11.0%	11.9%
\$10, 000 - \$19, 000	10.4%	14.2%	8.5%	12.0%
\$20, 000 - \$29, 000	7.0%	7.5%	8.5%	9.3%
\$30, 000 - \$39, 000	6.1%	6.6%	8.5%	8.0%
\$40, 000 - \$49, 000	5.2%	7.5%	5.1%	7.4%
\$50, 000 - \$59, 000	6.1%	5.7%	7.6%	6.5%
\$60, 000 - \$69, 000	3.5%	5.7%	7.6%	5.5%
\$70, 000 - \$79, 000	5.2%	4.7%	5.9%	5.3%
\$80, 0000 and over	7.0%	2.8%	6.8%	4.8%
\$90, 000 to \$99, 000	4.3%	5.7%	4.2%	4.3%
\$100, 000 and over	34.8%	24.5%	26.3%	25.0%
Private Dwelling Composition				
Total Occupied private dwellings	295	300	360	3,660
Single-detached house	35.6%	15.0%	16.8%	16.8%
Apartment in a building that has 5 or more storeys	0.0%	0.0%	9.7%	9.7%
Single-detached house	35.6%	15.0%	16.8%	16.8%
Apartment in a building that has 5 or more storeys	0.0%	0.0%	9.7%	9.7%
Apartment or flat in a duplex	0.0%	3.3%	4.4%	4.4%
Apartment in a building that has fewer than five stories	33.9%	68.3%	52.2%	52.2%
Ethnic Composition				
Total – Ethnic origin for the population in private households – 25% sample data	1,070	875	1,025	9,960
North American origins	25.7%	17.7%	15.6%	18.4%
European Origins	63.1%	65.1%	72.2%	64.0%
Caribbean Origins	0.9%	2.3%	2.0%	1.9%
Latin, Central and South American Origins	0.9%	5.7%	1.5%	1.9%
African Origins	0.9%	1.1%	2.0%	1.7%
Asian Origins	8.4%	2.9%	6.8%	11.4%
Oceanic origins	0.0%	16.1%	0.0%	0.7%

GHOSTS IN THE CANON: LOGISTICS IN GEOGRAPHIC THOUGHT

By Alison Zhou

In the last four decades, scholars have come to appreciate the role of logistics in winning wars, fuelling economies, and enabling or disabling social reproductions. In this article, I attempt to situate the turn towards logistics in geographical thought by tracing its intellectual histories and precedents. Through the likening of the intellectual maturation of logistics to its parent subfield of military geography, I also argue for the value and urgency of a critical engagement with logistics. A critical logistics scholarship makes explicit the circulation and consolidation of military power, data, surveillance technology, infrastructure, labour, affects, capital, and ideas, as well as larger compositions of social and physical landscapes that make logistics possible. Given the longstanding interest in the production of unevenness and space, and in a world where logistics is becoming an increasingly salient force in reshaping time-space, logistics becomes a necessary framework to study “the spatiality and territoriality of organized violence,” a matter that has certainly concerned geographers for a long time (Cowen, 2014, p. 47).

Introduction

In the last four decades, scholars have come to appreciate the role of logistics in winning wars, fuelling economies, and enabling or disabling social reproductions. The spatiality of logistics depends on “complex calibrations of multiple locations,” circulations, and flows, as well as attendant cartographies of supply-chain management and just-in-time production, and has been taken up in novel ways by geographers in particular (Cowen 2014, p. 205). In this essay, I will attempt to situate the turn towards logistics in geographical thought by tracing its intellectual histories and precedents. I will limit my attempt to trace the genealogy of logistics-thinking to after the “revolution in logistics” following World War II, though the substantial part of my essay will be focused on the last 20 years, when a constellation of geographers began to explicitly center logistics in their research. First, I offer a survey of contemporary engagements with logistics across the discipline, a brief but useful exercise. Second, I visit some of the geographic knowledges produced by the United States military after World War II. This is significant because contemporary engagements treat this as a defining moment in the development of logistics. I then focus on three areas of geographic inquiry from which the literature borrows some of its conceptual underpinnings: transportation geography, military geography, and geoeconomics. Lastly, I discuss future directions for logistics. Through this exercise, I hope to convey the urgency and value of a logistics scholarship in geography.

Making, Moving, Blocking: Logistics in Contemporary Mobilities Studies

The recent surge of scholarly work on logistics borrows conceptual material from a number of cognate fields such as feminism, economics, and object studies. Through encounters with these fields of study, geographers have engaged with “similar questions and research objects using different

analytical frames and theoretical categories” (Chua et al., 2018, p. 617). There are a number of other sources of inspiration for contemporary logistics research, including the quantitative revolution from the 1960s onwards and its critics, Marxist theories of capital accumulation in the 1970s and 1980s, post-structuralism and critical theory in the 1980s and 1990s, and more engaged forms of geographic practices such as radical, feminist, and postcolonial geography (Chua et al., 2018).

Generally, geographers approach logistics in two ways: as a means to or as an object of study. The former approach includes trends in geographical thinking such as “follow-the-thing” methodology, which includes as its subject anything from the playful to the lethal. On the other hand, the industry and organizing logics of logistics itself are considered in patterning material entities and social relations, as well as shaping of civilian space by military objectives, rationales, technologies, and structures (Woodward, 2005, p. 721).

Transportation geographers have been concerned with the study of goods movements and freight logistics over the last half century, including the changing geographies of ports, waterfronts, and cities in light of technological advances in containerization and transshipment (Hesse & Rodrigue, 2004; Cowen, 2014). Geographers interested in science and technology have also considered logistics as part of “mobile sociotechnical systems” consisting of human and nonhuman components (Pellegrino, 2012).

Related to transportation geography and the spatial turn of the 1980s is the “new mobilities” paradigm (Sheller & Urry, 2006). Transport geography is “perhaps the most immediate precursor” to new mobilities (Cresswell, 2011, p. 554). More accurately, the new mobilities paradigm is an interdisciplinary approach to studying movement and flows, just one offshoot from the wellspring of ideas that emerged from the postmodernist turn in geography. It troubles sedentarist theories in geography and the previous lack of consideration for the social in socio-technical transport systems. The mobilities turn was prompted by the increasing transmission of people, goods, capital, data, diseases, ideas, and so forth across space, and the attendant power relations through which the act of moving is imbued with social, cultural, and psychic meaning (Cresswell, 2006).

Usefully, this approach to logistics directs research away from static structures, including discourses of “stillness,” in Cresswell’s words (2014, p. 718), and the end of the nation-state, to see “how social entities comprise people, machines, and information/images in systems of movement” (Sheller & Urry, 2006, p. 210). Geographers have shifted away from the language of scalar descriptors, such as local/global, to a language of “fluid modernity” to describe logistics (Sheller & Urry, 2006, p. 209). The emphasis in logistics scholarship on the speed in which people, money, images, information, and so on move, gestures towards the postmodern conception of spatiality, in which “the substance of places” is in constant motion (Thrift, 1996). At other times, geographers echo the language of the late modernists when writing about logistics (Bauman, 2000). These geographers theorize logistics as an organizing logic of liquid modernity, one that is prefaced on speed and just-in-time production; “a continuous, Heraclitean flux,” where “the factory dissolves into planetary flows, chopped up into modular, component processes which, separated by thousands of miles, combine and recombine according to the changing whims of capital” (Bernes, 2013).

This, however, does not suggest—or should not—an emancipatory modernity. The new mobilities paradigm, and how logistics geographers have interpreted it, is just as concerned with immobilities. As Cresswell writes, “molecular vibrations are not much comfort... to Palestinians who cannot walk through the wall that has been built between their homes and their farmland” (2014, p. 716).

Indeed, immobilities and time-space asymmetries cannot be whisked away by high theory. Nevertheless, geographers of logistics have engaged positively with the mobilities perspective, beyond its use as a placeholder for terms such as “transport” or “migration,” to capture a deeper theoretical and methodological shift away from sedentarism (Cresswell, 2014, p. 718).

Parsing Logistics from Military Geography

In placing logistics rather loosely in the lineage of military geography, I will attempt to note some of the connections between how geographers understand and approach these terms. The first is the traditional study of military geography, which studies the application of geographical tools and theories to solve military problems. The parallel approach to logistics similarly aligns itself with the objectives of states and militaries. In the words of Bruce Allen, former Director of the Wharton School of Business, logistics applies itself to the formal science of “managing the supply chain: from raw material assembly, to work in progress, to the physical distribution of the final product or service,” and thus prevents itself from fully contending with its contested geographies (Allen, 1997, p. 106). The steady growth in academic interest in the specialized world of instrumental logistics research began roughly in 1960, coinciding with the proliferation of logistics as a business study (Smykay & LaLonde, 1967, p. 108). Similarly, through the 1940s and 1950s more generally, geographic knowledge “valued by the military was not particularly distinct from that deemed academically sophisticated” (Farish, 2015, p. 43). In other words, this approach characterises the work that geographers, and scholars more broadly, have done in the service of logistics. The relationship between corporate and military logistics remains so entangled that many of Wal-Mart’s managers and executives, for example—who set industry-wide standards for best practices—are recruited from the military (Bergdahl, 2006, p. 155).

From this view, the infancy of the field of logistics owes to the fact that up until the Second World War, “the field of corporate or business logistics did not exist at all” (Bernes, 2013). Until then, logistics was a military affair, referring to the methods that armies use to sustain themselves and to move supplies from the rear to the front line. The aforementioned “revolution in logistics” refers to a paradigm shift beginning in the 1950s due to a proliferation of information exchange between members of the military, academic, and private sectors, transforming logistics from a military tactic to a business science (Bernes, 2013; Cowen, 2014).

The lessons from the Korean War and World War II were not lost on experts: you had to support the troops to have a successful war effort. Though entrepreneur Malcolm McLean had introduced stackable shipping containers in the 1950s, and had already containerised some domestic transport lines, it was only in 1965 that the technology was established as the most efficient and risk-averse option for international trade, through a \$75 million contract McLean won with the U.S. Department of Defence for Sea-Land Service’s container-based solution to the logistics crisis of the Vietnam war (Levinson, 2008, p. 184). Geographers have identified the three decades after World War II as a defining moment when periodizing the revolution in logistics, citing the “tremendous amount of intellectual labor” as well as the “establishment of degree programs and research institutions...trade journals, professional associations” and new corporate structures as well as broader logics and imaginaries. The first distribution and logistics program to be institutionalized, for instance, were by the University of Michigan in 1957, and RAND Corporation’s Logistics Research Lab (Cowen, 2014, p. 31). The innovations and information exchanges happening at the time signalled that a change in the reputation of logistics was afoot in professional and military discourses (Cowen, 2014, p. 28).

Without overlooking the immense importance of such technological advances in logistics during the mid-20th century, Hesse (2008, p. 31) reminds us that modern logistics has intellectual roots dating back to the modernization of the capitalist economy. Marx, who referred somewhat ambiguously to processes of distribution, argued that it was the “sphere of circulation” suspended between production and consumption that enabled use-value to transform into exchange-value, making possible the large-scale capture of capital (as cited in Harvey, 2001, pp. 237-266). Given that the generalized practice and pursuit of a formal science of geopolitics (with its own presumed authority on military, social, and economic strategy) was a post-Enlightenment European invention, what was still missing was a precise research project on pre-WWII theories of logistics (Cowen & Smith, 2009, p. 23). Earlier writing on the military-industrial complex heavily implicates logistics as well, even if that was not the language used to describe it as such.

Unsurprisingly then, scholars began to write critically about logistics shortly after the proliferation of logistics as an academic subfield in the 1950s and 1960s. The second approach is to understand logistics/military geography in terms of the spatiality of armed conflict, an approach that “predominantly [originates] from political geography” (Woodward, 2005, p. 721). Others place logistics scholarship within a lineage of political-geographic logic of economy that is somewhat “at variance” with geopolitics scholarship (Cowen & Smith, 2004, p. 24). The third approach to logistics, analogous to that of critical military geography, acknowledges “the significance of armed conflict,” but also “looks beyond it for what it tells us about the wider geographical imprint of militarism and military activities” (Woodward, 2005, p. 721). The critical logistics research agenda seeks to examine how circulations of bodies, capital, and matter reconfigures social relations “with and against profit and power” (Chua et al., 2018, p. 621). Under the assemblage of geopolitics, authority and expertise in the science of war were increasingly relegated to the outside-facing military following the bourgeois revolutions in Europe. Following decolonization and US imperial ambition, however, the ideological separation between external and internal forms of security became obvious. As geopolitical social forms were recalibrated by market logics, the roles of the military and police began to fold into each other, and it became more transparent that domestic politics have always been concerned with nation-to-nation wars (Cowen & Smith, 2009, p. 25). Logistics scholarship leans heavily on this geoeconomic analysis, which understands divisions between civilian and soldier, inside security and outside security, as increasingly contaminated as they have been recalibrated by transnational market logics. Kanngieser (2013), for example, traces the leakage of logistical reason into everyday spaces like the workplace through case studies of logistical technology, like the use of radio frequency technology identification (RFID) tags to remotely track warehouse workers’ movements. Therefore, logistical routes and boundaries are more fluid, fuzzy, and porous than principles of geopolitics would suggest.

Geographers also employ logistics as an analytical frame to highlight the uneven power relations and violence underpinning it (Chua et al., 2018, p. 618). At the same time, they take the position of exposing inconsistencies in logistical practices and regimes: “in exposing the flaws, irrationalities, and vulnerabilities” of logistics, geographers open up possibilities of making different futures within our worlds (Chua et al., 2018, p. 625). This does not mean that we are all equally condemned to live in the logistical worlds of techno-determinist scholars. Theories of geoeconomic calculation are highly uneven and episodic, both temporally and spatially, and can never fully supplant geopolitics (Cowen & Smith, 2009, p. 42). From this perspective, geographers argue that logistics is a useful analytical frame to study the transformation of the physical circulation of goods and materials as well as the economic restructuring of global space.

Logistics in the Warring State: Mobilities in Geoeconomics

The same shifts underpinning developments in mobility and military studies have animated a growing body of research on global commodity chains, global value chains, and global production networks, as well as the securitization of trade routes, borders, ports, and other critical flashpoints. The study of security is not new in mobilities literature (Sparke, 2006; Thrift, 2011). More recently, geographers have recast security studies in relation to logistics, tracking the latter's deployment in ways that organizes bodies, capital, and things into a "logistical epistemology" (Cresswell, 2014, p. 718).

Despite the wealth of geographic scholarship on production and consumption, the phenomenon that comes before consumption and after production, of distribution, has largely evaded intellectual scrutiny until recently (Cresswell, 2014, p. 716). Another way of saying distribution is logistics. This emergent geography combining economy and security, what Luttwak named "geoeconomics," seeks to capture the logic of war within the grammar of commerce (1990, p. 19). Since Luttwak's proposition, scholars have applied the principles of geoeconomics to theorize representations of logistics space, what Thrift contends is "a central arena in which capitalism is finding new ground to extract profit through a constant process of mobilizing commodities, emotions, and affect" (2012, p. 144). Needless to say, the securitization of trade flows and supply chains falls squarely into the domain of logistics, making geoeconomics a meaningful place from which to create logistical theories of power and space anew.

Almost two decades after the seminal article "From Geopolitics to Geoeconomics" was published, Cowen and Smith (2009) take Luttwak to task. They point out that Luttwak assumes a natural progression in the era of globalization that markets will become increasingly powerful, resulting in the erosion of the relevance of territory and time-space. Furthermore, they reject Luttwak's periodization of geopolitics with geoeconomics as its successor—geopolitics will never be fully eclipsed by geoeconomics. Rather, they argue that the study of space, power, and security can no longer be captured fully by geopolitical discourses "as market calculation supplants the geopolitical logic of state territoriality" (Cowen & Smith, 2009, p. 43). They understand spatial articulations of geoeconomics as inseparable from ongoing shifts in political geography (Cowen & Smith, 2009, p. 25).

A geoeconomic conception of security considers social forms together that geopolitics kept distinct, such as the external (military) and the internal (police), to describe how social forms of citizenship and the state are being recast as geoeconomic actors. It underlines conflicts between logics of nationhood and transnational flows, and turns our attention to the increase in non-state and private actors in security as well (Cowen & Smith, 2009, p. 28). In reinterpreting the Iraq for example, they contend that terrorist threats and oil were secondary to a "deeper geo-economic aspiration for global control"; it was a market war (Smith, 2003, p. xiv). This rewriting of the Iraq War, and subsequent interventions in Iran and Syria, heavily implicates logistics in the military-industrial complex. To illustrate this point, one only needs to recall the hundreds of corporations staffed with as many as 130,000 mercenary war labourers, or private contractors in logistics-speak, profited from more than \$864 billion of state funding for warfare and failed reconstruction (Scahill, 2007; Cowen & Smith, 2009).

Future Engagements with Logistics

Geopolitics has been criticised for overlooking “the little things,” which, as Thrift notes, have hindered scholars from “understanding how (and therefore why) geopolitics is actually practised” (2000, pp. 380-387). In response, recent logistics scholarship has taken up recent trends of embodied and ethnographic writing about everyday space. For example, Chua (2014) maps the logistical economy of racialized containment through an ethnography of (disruptions in) the transpacific container trade.

Logistics scholars themselves characterise logistics to mean the residual and uncomplicated, the bureaucratic and the mundane, as opposed to the monumental. Their aim is to reveal the scales and degrees to which the invisible work of logisticians has contributed to organized violence (Cowen, 2014, p. 25). Could this, ironically, replicate the same hyper-masculine discourses that dominate studies of military geography today, even by its most critical writers? To draw a parallel, Barnes (2015) rewrites Nazi military strategy (which notably, was internally rather than externally-facing) as the work not of soldiers, but bureaucrats—logisticians. Killing in Nazi Germany was mediated by arms of the bureaucracy like The Ministry of Transportation of the Final Solution. Writers like George Orwell and Aldous Huxley diagnose the evil banalities of modernity through inventions like Miniluv and Minitru, the programming of humans in embryo into brainless workers. In a way, they were anticipating the rise of logistics.

Scholars also ought to be cautious not to lose themselves entirely in an Alice-in-Wonderland sort of logistical world. Critical scholars and retired military consultants are using strikingly similar language to capture the phenomenon—“a continuous, Heraclitean flux” (Bernes, 2013), a “21-st century scalable Lego-like force design” that can keep up with the “messy capitalism” of our time (cited in Morrissey, 2015, p. 106). While logistics scholars have been careful to highlight the intimate connections and local scales of logistics, there is room for an explicitly feminist analysis to disrupt the hyper-masculine discourses that dominate logistics scholarship. Feminist geographer Silvia Federici, in an interview with Elliott and Franklin (2018) points to the everyday social reproduction that facilitates technologies of capital accumulation, of which logistics is one.

I read Derek Gregory’s concept of woundscape as one example of taking seriously Federici’s feminist reading of Marx. Quoting an American captain who served in WWII, Gregory (2018) recites:

Here was this line of men, who little more than an hour ago were normal men in the finest of health and strength, and now... with every degree of injury, they painfully made their way back to the human repair department. The well men were rapidly moving eastward in countless numbers, while the injured so laboriously dragged their way back, two human streams... Before us, all energies were devoted to destruction; behind us, all human power and skill tried to repair the damage.

How do flows and circulations in war, such as the one of foot soldiers that Gregory (2018) evokes, reveal the stakes in exposing the infrastructures, knowledges, labour, bodies, and technologies—the logistics—that facilitate it? A woundscape, in highlighting the “bio-physical, cognitive, and affective landscapes in which casualties are created, moved and treated” centres the wounded rather than the inflictors of those wounds. In doing so, it acknowledges the limits of analyses that overlook the intimate, affective, and embodied aftermaths of bureaucrat killers and war logisticians.

As useful as it is to conceptualise logistics through a language of fungibility and fracture, the pre-history of logistics as supplied by Marx and Harvey also points us in future directions that may be at slight variance from present scholarship. Clearly, logistics in practice is a means to other ends, though the means may also present highly extractible profits as seen in Macgregor's vision of Lego-capitalism. In what ways is thinking structurally (but not statically) about logistics productive? How can the process of distribution be welded back onto sites and structures of production and consumption?

Conclusion

Disciplinary engagements with logistics over the last two decades reflect a broader trend towards cross-disciplinary approaches to spatial matters. Why does logistics, then, have theoretical purchase in geography above other social sciences? Though the theory and practice of conventional military geography have not faded completely, I argue, through the likening of the intellectual maturation of logistics to its parent subfield of military geography, that the study of logistics signals a return of military studies to the heart of geography. The nature of logistics is such that it thrives on being “backgrounded.” A critical logistics scholarship makes explicit the circulation and consolidation of military power, data, surveillance technology, infrastructure, labour, affects, capital, and ideas, as well as larger compositions of social and physical landscapes, that makes logistics possible (Cresswell, 2014, p. 716; Kanngieser, 2013). In other words, logistical imaginaries can only be enacted “through the production of space... to quantify and optimize circulation” (Chua et al., 2018, p. 618).

If modernity finds its perfect geographical expression in logistics space as Rossiter (2016) suggests, then it would seem unsurprising that logistics has prompted geographers to return to some of the most fundamental concerns first raised in critical military studies and geopolitics, and more recently in mobility studies and geoeconomics. In making an analogy between intellectual histories of military studies and logistics, I offer an explanation for why geographers have gravitated towards the subject. Given the longstanding interest in the production of unevenness and space, of more recently, geoeconomics, and in a world where logistics is becoming an increasingly salient force in reshaping time-space, logistics becomes a necessary framework to study “the spatiality and territoriality of organized violence,” a matter that has certainly concerned geographers for a long time (Cowen, 2014, p. 47).

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NEGOTIATING GENDER ON THE FACTORY FLOOR: WOMEN'S WORK AT THE FORD RIVER ROUGE PLANT

By Cora Larkins

The addition of millions of women to the labour force during World War II was considered a watershed moment—a time that challenged Canadian and American societies' traditional views of women's work. This paper critically interrogates the cultural narrative of women working in factories during World War II as a force for gender equality in the workplace. Scholarship on management practices and trends in the sexual division of labour during and after the war contradicts this popular understanding. Using the Ford River Rouge plant as a case study, this paper highlights long-term setbacks for gender equity resulting from wartime practices. Doreen Massey's concept of Power Geometry provides a framework for analyzing the various social relations and forces shaping these trends.

The addition of millions of women to the labour force during World War II was originally considered a watershed moment—a time that challenged Canadian and American society's traditional views of women's work (Rose, 2018). Using Doreen Massey's (1993) ideas of “interaction” and “articulation” as a lens, this paper traces how social relations on the factory floor and the wider processes and ideologies in society at large came together to strengthen the gender division of labour in the factories during and after World War II. I argue in this paper that despite the mass mobilization during World War II of women into war-time jobs on the factory floor—especially jobs traditionally considered “men's work”—the result was not a reduction in the sexual division of labour in these factories but the strengthening of it. The Ford River Rouge plant outside of Detroit exemplified the phenomenon of women taking over “men's work” and then, post-war, being shifted back into domestic roles.

Doreen Massey explains in “Power-Geometry and a Progressive Sense of Place” that every place is unique and created by a specific combination of social relations—local, broad, accumulated, and new—that come together at a particular time to construct a moment or place that may not otherwise exist (Massey, 1993). Analyzing the “interactions”—relations within a place—occurring on the factory floor between workers, managers, and unions in conjunction with the “articulations”—relations beyond the place—at play outside of the factory such as government policies, industrial practices, the media, and cultural attitudes, allows for a better understanding of how and why this place came to be. Regrettably, the scope of this paper does not allow for an examination of all the social relations at play—class and race are two categories that are layered upon, and interact with, gender complexities.

The mobilization of women into the labour market during World War II in Canada and the United States was unprecedented. In Canada, 1.1 million women entered the paid labour market from

1939-1944, with 300,000 of them entering roles in heavy industry and other manual jobs classified as “men’s work” (Keshen, 1997). In the United States from 1940-1944, an additional 6.7 million women joined the labour force, representing a fifty percent increase in pre-war participation. In the United States, women entered jobs previously considered “men’s work,” with more than three million of these jobs being in manufacturing, such as ammunition and aircraft factories (Rose, 2018). These statistics are consistent with the popular cultural understanding of the opening up of traditionally male-coded heavy labour to women during the war. However, once the war ended, the flood of women into the industrial workforce receded almost as quickly as it had come in. By the end of 1945, over one million American women had been laid off. In manufacturing as a whole, women were laid off at rates double those of male workers; by 1951, less than half as many women were employed in the auto sector as had been in 1944 (Milkman, 1987). The absence of women in these roles was not due to a lack of desire to work. In a survey done by the United Auto Workers (UAW) in 1944, eighty-five percent of female respondents said that they intended to stay and that they would prefer to do factory work (Milkman, 1987). Records from the U.S. Employment Service (USES) also show that women wanted to continue working in the post-war period. In the first quarter of 1946, 660,000 female applicants applied for work through USES, and substantial numbers of women applied for unemployment compensation of which an active job search was a requirement (Rose, 2018). An indication of the gender-biased labour market was that sixty to eighty-one percent of jobs posted at USES specified that the jobs were for “men only”; further, in many cases women were paid rates that were forty-five percent lower than they had been paid during the war (Rose, 2018). Thus, women’s gains made during the war were ultimately revealed to be transient.

The Ford River Rouge plant exhibited the labour trends seen during the mobilization and reconversion periods. Prior to the war, there were only forty-five women working at the plant. By late 1943, women accounted for 14,800 of the 93,000-person workforce, representing a dramatic influx of female workers (Kossoudji & Dresser, 1992). Yet the end of the war saw an equally dramatic emptying-out of the female workforce at the factory: from October 1943 to October 1945, while overall employment in auto fell by forty percent, women’s employment decreased by seventy-five percent (Milkman, 1987), and by the end of 1946 women represented only one percent of the River Rouge factory’s hourly workforce (Kossoudji & Dresser, 1992).

The mobilization of women into factories during World War II was primarily driven by a link between the needs of private industry and wartime government strategies. Migration of women to industrial, urban centres was encouraged by the aggressive propaganda and recruitment efforts of the federal government (Pierson, 1983). Recruitment was required to fill a critical labour shortage formed by increased wartime industrial production and men going to fight in the war (Rose, 2018). In Canada, recruitment was undertaken by a newly formed agency, the National Selective Service (Pierson, 1983). In the United States, recruitment of women into labour positions was the responsibility of the War Manpower Commission and the Office of War Information. All three agencies used extensive national publicity campaigns to make the prospect of industrial war work popular with women and actively worked to erase the opposition industrial managers had to hiring women (Yesil, 2004). The government propaganda campaigns were also used to shift public opinion—the key messages were that a married woman had the right to work, and that their participation would not interfere with their domestic work and family responsibilities or the working standards of other wage earners (Weiner, 1985). The articulations between government and industry, and between government and domestic relations, were characterized by deliberate manipulation to achieve specific policies oriented to preserving traditional female social roles.

The wider processes and relations at play at the national and international level are key to understanding how society viewed women and women's work during this period. To look at only the relations occurring on the factory floor or in a particular industry does not give the full picture. It's important to look through a wider lens at the complexity of the geographical context. One of the most influential of the wider processes was propaganda—a term not commonly associated with the domestic front.

Government propaganda and the popular media relied heavily on imagery as a tool to break down the societal notions of what type of work was appropriate for women. The images often depicted a white housewife dressed in factory clothing working temporarily. The understanding was the work was only being done for the duration of the war—primarily for patriotic reasons—and that she would leave the factory as soon as the war was over (Weiner, 1985). Rosie the Riveter and Ronnie the Bren Gun Girl are enduring examples of the images used to idealize women's participation in the labour force (Yesil, 2004). It is unlikely that the shift to hiring female factory labourers would have occurred without the government actively managing the nation's human resources.

The connection between cultural attitudes and industrial practices required a re-framing of women's work in factories to accommodate traditional notions of female labour. This resulted in significant changes to the interactions within factories as management-imposed changes intended to reconcile the presence of female industrial workers with existing cultural attitudes. During the war, the boundary between women's and men's work was not eliminated, but instead it changed locations (Milkman, 1987): with the domestic/commercial boundary no longer tenable, factory managers were forced to re-create the gender-delimiting boundary within industrial spaces themselves. For most managers, the working woman during this period was just extending her domestic space to help out during a period of patriotism and national need (Santana, 2016). Labour segregation by sex had always existed, of course, but the wartime crisis amplified the segregation with sex-typing of war jobs—many of which were new roles for both men and women—and had no pre-war label (Milkman, 1987). Not only was the labour within the factory segregated by gender, work was also hierarchized, and some forms were privileged over others.

Thus, a major task for factory management during the war—and a major change to the social interactions within such factories—was the reproduction of job segregation even as millions of women were being added to the workforce (Milkman, 1987). In factories, women's work was often compared to a domestic equivalent such as needlework or sewing utilizing qualities that were perceived as inherently feminine, such as dexterity, attention to detail, and patience that could be used for similar factory work. Job assignments were made by management and women were hired into jobs that they considered suitable for women (Milkman, 1987). In a survey taken in 1943, the roles of auto workers in Detroit were placed into seventy-two job classifications: women worked in only five of these classifications, and only eleven percent of the men were also employed in these five areas (Milkman, 1987). Management would offer the same reasoning for job classifications as it had done in the pre-war period—physiological and social abilities were often cited as the basis for job segregation. The use of adjectives like “light” and “heavy” and “clean” and “dirty” were used to differentiate women's and men's work (Milkman, 1987).

One of the results of jobs being characterized as “female” was the introduction of increased mechanization and work simplification (Milkman, 1987). In the auto industry, the feminization of work was met with the introduction of mechanical aids such as hoists, lifters and conveyors to help women do “men's work”. The work was further simplified by the addition of more women workers; each

responsible for one small aspect of the process and the addition of two or three men to “service” the women by doing the “heavy” work required in the process (Milkman, 1987). Management’s use of sex-typing tied to the physical limitations of women allowed for two things: justification for a sexual division of labour and a foundation for increased mechanization (Milkman, 1987). In terms of the power geometry, interactions between management and labour within the factory gave rise to these new forms of interaction between male and female labourers, and these new dynamics were themselves dictated by the articulations between industrial practices on the one hand and both government wartime policies and culturally-dictated gender norms on the other.

Articulations between industrial capital and labour unions, and interactions between union leadership and female labourers, also contributed to the gendered division of work within factories during the war. While female union membership surged—rising from eight hundred thousand members in 1940 to three million members in 1944—the labour movement did not have a feminist focus, and records show that fewer than two percent of strikes during the war were exclusively female workers (Milkman, 1987). While the United Auto Workers (UAW), operating at automotive plants like Ford’s River Rouge, advocated “equal pay for equal work”, the union sanctioned the practice of paying women lower wages as long as they were restricted to “women’s work” (Milkman, 1987). Thus, the creation of gendered work categories at plants like River Rouge allowed unions to favour their existing male members while paying lip service to the notion of non-discrimination in wages. All of these practices and interactions within factories like the River Rouge plant served to insulate the factory floor against long-term changes in social attitudes toward female workers.

In the post-war reconversion period, when factories were converting back to their original production purpose, there was a considerable shift in the gender makeup of the factory floor. While it is true that some women wanted to return to their domestic lives, it is also true that many women wanted to remain as industrial workers (Kossoudji & Dresser, 1992). However, women were laid off at much higher rates than men, and when post-war production resumed, inexperienced men and war veterans were hired in their place (Milkman, 1987). The management of plants like River Rouge claimed that the production of cars was so different from bombers that the jobs women had performed no longer existed, and that the new jobs were too “heavy” to be suitable for women (Kossoudji & Dresser, 1992). Perversely, even the improvements to factory efficiency due to war-time mechanization were used to illustrate the incapacity of female workers and their inferiority now that male workers capable of performing “heavy” work had returned (Kossoudji & Dresser, 1992). In time, of course, the mechanization introduced during the war would go on to undermine the bargaining power of labour leading to the decline of industrial labour in the United States, Canada and elsewhere and contributing to the precarity of both male and female workers.

After the war, domesticity campaigns proliferated in mass media: advertisements promoted domestic consumerism and the ideal family with the goal to remind society that a woman’s place was with her children and in the home—not in the factory (Santana, 2016). Government welfare and veterans’ programs allowed families to purchase homes for the first time, increasing the demand and expectation of female domestic labour (Keshen, 1997). Once again, the factory floor had evolved: no longer the place it was during the extreme circumstances of war, but a new, unique place progressing with the specific social relations at play in that particular moment. Massey’s power geometry provides a useful framework for analysing the continually evolving differences generated by social relations and how impersonal, structurally or culturally-defined forces shape places.

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SEX TOURISM IN BATAM: A MULTISCALAR ANALYSIS

By Daria Mancino

The sex tourism industry in Batam, Indonesia is often characterized as a by-product of broad economic forces, particularly the relationship between Batam's development and Singaporean capital. This paper seeks to expand this conceptualization and analyze the multiscalar transnational linkages that both exert influence on and are shaped by Batam's sex tourism industry. This industry is shaped by the unequal power balances within the "Growth Triangle" of Singapore, Indonesia, and Malaysia which led the Indonesian government to regulate sex work to further its economic interests. Simultaneously, this has contributed to the feminization of labour on the island. However, the sex work industry is also influenced by forces that operate at the scale of the body and the family. Sex workers understand their labour in terms of familial obligations and culturally significant feelings of *malu*, or shame, which lead to acts of constrained agency. Altogether, the sex tourism industry in Batam is best understood in terms of the mutually constitutive relationships that exist between these scales of analysis.

Introduction

Batam is an Indonesian island situated within the Riau Archipelago, a short distance from both Singapore and the Malaysian province of Johor. In the past several decades, Batam has experienced rapid economic growth which has changed the nature of the economy and the social relations on the island (Dalzell et al. 2005; Eriksson & Lindquist, 2005). Particularly, the economy has become dependent on both feminized work and Singaporean capital (Dalzell et al., 2005). One element of this feminized work is sex work, an industry that is fuelled by demand from Singaporean male tourists whose home country controls the sex industry much more strictly (Jones, Sulistyarningsih & Hull, 1998). As suggested by Kempadoo (2001), sex work is now vital to many Asian economies that rely on tourism in an increasingly neoliberal international system which seeks to commodify all aspects of life and encourage free-market capitalism. In Batam, sex work has become central to the island's economy and attracts both wealthy tourists and female migrants in search of work (Jones et al., 1998).

While the sex tourism industry is often thought of solely in terms of broad economic forces, in my paper I will argue that the sex tourism industry in Batam is both shaped by, and exerts influence on, multiscalar transnational linkages. These linkages occur at global and national scales, particularly in flows of capital and migrants, but also at the scales of the body and family which impact social relations. To analyze the mutually constitutive relationships between these scales, I will begin by situating my work within the broader framework of sexual labour provided by transnational feminists. I will then analyze Batam's sex industry at the regional scale, specifically its location within

the “Growth Triangle” of Indonesia, Malaysia, and Singapore which is often thought of in solely economic terms but also has important ramifications for the bodies of sex workers and the maintenance of power structures in the region. Finally, I will shift my analysis to the scale of the body and family, analyzing the effects of familial obligations, pride, and shame on female sex workers and Batam’s sex industry at large.

Transnational Feminist Perspectives on Sex Work

The growth of the sex work industry is fuelled by women’s experiences of economic precarity under global capitalism. This conceptual framework is central to the transnational feminist perspective on sexual labour, exemplified by the work of Kamala Kempadoo. Kempadoo (2003) situates sex work within the post-1970 “global restructuring of capitalist production” (p. 144). This economic restructuring, which has involved an increase in precarious labour and a reduction in social services in many nations, has directly facilitated the growth of the sex sector worldwide and contributed to the feminization of labour and labour migration (Kempadoo, 2003). In these economic conditions, women are increasingly expected to provide for their families as heads of household while being employed in precarious, low-wage work, notably factory work in export-processing zones (Kempadoo, 2003). For many women, engagement in sex work becomes necessary to supplement their wages and provide for their families (Kempadoo, 2001). It is important to understand the structural factors that underwrite the prevalence of the sex sector worldwide, especially as racialized women continue to be disproportionately disadvantaged by global capitalism.

Kempadoo also specifically analyzes the growth of the sex tourism industry and its centrality to many local economies. Tourism has generally been promoted as a development strategy for “poor countries” to integrate into the global economy, and as such many national economies have become reliant on tourism to secure investment and capital (Kempadoo, 2003). Kempadoo analyzes how some governments have not only embraced tourism to spur economic growth but have explicitly relied on stereotypes of Women of Colour as “exotic” to attract tourists and secure investment (2003). This sexual labour “fills the coffers of countries whose survival is increasingly dependent on global corporate capitalist interests,” showing the complicated relationship between the governing of women’s bodies and reliance upon the same bodies for economic development (Kempadoo, 2001, p. 144). This is particularly salient in Batam, where the Indonesian government regulates and controls sex work as a quasi-legal industry to serve its economic interests (Jones et al., 1998).

Finally, it is important to consider the victim/agent dichotomy often presented in research on sex work. Kempadoo notes that while white radical feminists have called for the abolition of sex work as an inherently patriarchal and victimizing occupation, this perspective ignores the agency of many women who “strategically use their sexual labour” to respond to the effects of globalization (Kempadoo, 2001, p. 43). While many women choose to engage in sexual labour, Kempadoo notes that their agency is constrained by structural factors, particularly experiences of economic precarity which make sex work necessary to some women’s survival (2001). Lim (1998), in her analysis of sex work in Southeast Asia, also notes that experiences of sex work vary greatly depending on the mode of entry, which can be voluntary, the result of economic need, or the result of coercion or force. It is therefore important to take a nuanced approach to sex work in which researchers support and work with women who engage in sexual labour to secure labour stability and safety, but also address the structural barriers they face, particularly the devaluation of their labour, which heightens women’s experiences of marginality and forces many women to adopt sex work to support their families (Kempadoo, 2001).

Batam and the “Borderless World” of the Growth Triangle

The effects of economic globalization on sex work, as outlined by Kempadoo, feature prominently in Batam. The island’s geographic location within the “Growth Triangle” of Indonesia, Malaysia, and Singapore in particular has spurred the development of its major industries of manufacturing and tourism and has been touted as the key to Batam’s economic success (Sparke et al., 2004). The Growth Triangle is premised on the idea of economic complementarity, in which Singapore provides capital and Malaysia and Indonesia provide land and labour (Sparke et al., 2004). This triadic relationship, in theory, allows all three countries to benefit equally through unfettered inter-regional development (Sparke et al., 2004). This economic system has led the region to be called a “borderless world” in which the mobility of capital and people is completely unrestrained (Amster & Lindquist, 2005; Sparke et al., 2004).

However, flows of people and of capital are not free and are heavily influenced by pre-existing structures of power and privilege within the region. The so-called “borderless world” relies on increasingly regulated borders that exclude certain bodies based on class and race to maintain relationships of economic inequality (Amster & Lindquist, 2005). In the documentary *B.A.T.A.M.*, Lindquist notes that “Singaporean men travel to Batam for business and sex, but Indonesian migrants are supposed to stay in place on Batam” (Dalzell, et al., 2005, 21:10). Singaporean citizens can enter and leave Batam without scrutiny, as they can stay on the island for thirty days with a tourist visa. In contrast, Indonesians who try to enter Singapore must show adequate sums of money and are often rejected entry into the city-state if they are suspected of attempting to work illegally (Amster & Lindquist, 2005). This reality shows that the “borderless world” of the Growth Triangle does not create the equal economic and social opportunities it promises between all three nations. Instead, it allows structures of power to shape the experiences and mobility of people based on their class and social positionality.

These power imbalances are also evident in the relationship between Batam’s sex tourism industry and Singaporean capital. The growth of this industry has been spurred by demand from predominantly Singaporean men who are able to travel to Batam via a one-hour ferry ride (Amster & Lindquist, 2005). Once in Batam, they can drink, gamble, and engage with sex workers at a much lower cost due to the high purchasing power of Singaporean dollars (Ford & Lyons, 2008). The relative power of Singaporean men on Batam is a direct result of Indonesia’s unequal economic position relative to Singapore, and ultimately “these inequalities are played out on the bodies of... sex workers” (Ford & Lyons, 2008, p. 184). While Singaporean men come to Batam for pleasure, female sex workers on Batam face labour precarity, health risks, and violence in their work. Sex workers must constantly perform their labour under unequal power relationships between themselves and their clients, increasing their marginality (Ford & Lyons, 2008). The economic disparities between Indonesia and Singapore therefore do not only exert influence at the regional scale but place the disadvantages of globalization onto the bodies of sex workers themselves.

Batam’s reliance upon its sex tourism industry allows these power imbalances to be maintained. The sex tourism industry creates “a collection of interrelated industries and markets” that maintain the local economy, including entertainment, accommodations, shopping, and transport (Fager-tun, 2017, p. 336). The demand for sex tourism is integral to the growth of other sectors, which causes the island to prioritize resulting investment over the safety and valuation of its sex workers. While the sex tourism industry benefits the state and male tourists, it spurs the growth of informal economies which employ women in disproportionate numbers and treat them as “disposable” (Fa-

gertun, 2017). As a result, the benefits of tourism economies are uneven across gender and class, as impoverished women are most likely to face labour precarity and the devaluation of their labour as tourism grows under economic globalization (Kempadoo, 2003).

Sex and the State: Regulating Bodies for Profit

The relationship between sex tourism and economic growth has not gone unnoticed by the Indonesian state, which has capitalized on the industry and regulates it in a way that is conducive to its own interests. This is evident in the Indonesian Ministry of Tourism's web page advertising tourism in Batam, titled "Batam: Where Business Meets Pleasure" (n.d.). While the website makes no mention of the sex industry on the island, this title shows the explicit connection between the promotion of sex work and the state. The government's promotion of the sex industry actively capitalizes on the strict regulations surrounding sex work in Singapore, which encourage men seeking sexual services to travel to Batam (Amster & Lindquist, 2005). The strategic regulation of this industry shows the linkages between Singaporean capital and Indonesian economic interests, which benefit national economies at the expense of local bodies.

Lim notes that the sex industry often involves powerful corporate and governmental interests because of its close relationship with overarching economic development and its centrality to local economies (1998). In Indonesia, this led the state to regulate sex work as a quasi-legal industry in which the provision of sexual services is not criminalized but associated activities such as trafficking and "deriving profit from the prostitution of women" are illegal (Jones et al., 1998, p. 57). Through this policy, sex workers are able to work out of official, state-sponsored brothels, or *lokalisasi*, that are maintained and regulated by local governments under the auspices of rehabilitation programs (Jones et al., 1998). Women who work out of *lokalisasi* are surveilled and managed by the state, which directly profits from the sex workers' earnings. However, the state does not extend its labour laws and protections to sex workers despite the formalization of sex work through the *lokalisasi*, showing that the state actively devalues their labour (Jones et al., 1998).

The lack of labour protection and need to sacrifice portions of their earnings causes many sex workers to reject *lokalisasi* in favour of unofficial brothels or freelance work. These forms of sex work are more likely to be targeted by local authorities and shut down, as they circumvent the *lokalisasi* structures that directly benefit the state (Ford & Lyons, 2008). The governmental regulation of sex work, and the making of only certain kinds of sex work acceptable, shows a dual regulation of and dependence on female sex worker's bodies. This relates back to Kempadoo's critical analysis of the effects of economic globalization on the lives of sex workers (2003). The state endorses sex work as lucrative and central to its economy while surveilling and marginalizing the women who perform state-sponsored sexual labour. This complicates the supposed relationship between broad economic forces and the growth of an "underground" sector of the economy by showing the ways in which the state actively engages in the management of the sex tourism industry.

While the growth of the sex industry has been partially fuelled by demand and state interests, it has also been fuelled by the low wages women experience working in factories on Batam and elsewhere in Indonesia. Many women who come to work in factories eventually need to supplement their meagre wages and end up engaging in "double occupations" of factory and sex work to support themselves (Jones et al., 1998). Some women migrate to Batam specifically to work in the sex sector, which is seen as more lucrative than work in factories throughout the country or life in rural villages (Lim, 1998). It is important to note that these low factory wages are part of Batam's

attractiveness to Singaporean investment at the scale of the Growth Triangle. Thus, the growth of the sex sector is dually perpetuated by Singaporean capital and state interest. On one hand, the industry is fuelled by demand and capital from male Singaporean tourists, and, on the other, the state prioritizes Singaporean investment over the wages and living conditions of its predominantly female workforce, pushing some women into a sex industry that marginalizes them while continuing to serve state interests. This is demonstrated by the hypocrisy of state action regarding the two feminized economies in Batam; while the Indonesian government runs state-sponsored brothels to “rehabilitate” sex workers, it will not intervene to raise or supplement the wages of female factory workers—a structural factor that causes many women to enter the sex industry in the first place.

The sex industry in Batam highlights the issues with the so-called “borderless world” of the Growth Triangle through the regulation and restriction of sex workers’ bodies despite a reliance on their labour for economic development. It also shows the mutually constitutive relationships between these scales of analysis. While sex tourism is spurred by demand from Singaporean men, it is also sustained through government interests and the individual experiences of economic precarity faced by Indonesian women. Additionally, the relationship between the state and Singaporean capital shows that regional-scale inequalities are often played out on the bodies of female sex workers as their mobility is constrained and they are subject to greater scrutiny and marginalization by the state (Ford & Lyons, 2008).

Pride, Shame, and Transnational Families

While the sex industry and lived experiences of sex work are shaped by many macro-scale forces, sex work is also shaped at the scale of the family and the body. Sex work on Batam is influenced by two culturally-specific Indonesian concepts: *malu* and *merantau* (Lindquist, 2009). *Malu* translates most closely to shame or “appropriate shyness” and is central to Indonesian constructs of socially acceptable behaviour and morality (Collins & Bahar, 2000, p. 39). *Malu* is also closely tied to expressions of sexuality and premarital sex, making this feeling central to the lives of many sex workers. *Merantau* refers to a “circular migration” in which individuals go out into the world before returning home (Lindquist, 2009). Specifically, young adults are expected by their families to migrate to other parts of Indonesia to find economic opportunity and to return home once they have achieved adequate success (Lindquist, 2009). These two Indonesia concepts allow for an understanding of the impacts of familial obligations on the bodies and lives of sex workers in Batam.

The concept of *merantau* causes sex workers in Batam to view their work in terms of transnational linkages to family, which become complicated by feelings of *malu* related to the sexual nature of their labour. For example, in the documentary B.A.T.A.M., Dalzell, Eriksson, and Lindquist (2005) record the story of an Indonesian sex worker, Dewi, who migrated from Java to Batam in search of work to support her family. In the documentary, she describes how she feels both a sense of duty and shame in relation to her family; Dewi sends the money earned from her sexual labour home in the form of remittances, but also hides her identity in the documentary for the sake of her family (Dalzell et al., 2005). To her family, especially her father, “shame is worse than death” (Dalzell et al., 2005, 24:10). However, Dewi does not feel personally ashamed of her work and states, “I’m not ashamed of being a prostitute. I’m ashamed of failing my family” (Dalzell et al., 2005, 24:40). Dewi’s story shows that while many female migrants engage in sexual labour to support their families, the same families cause women to associate *malu* with their labour if they are unable to provide adequate financial support.

Dewi's story also shows the influence of female migration on the sex industry in Batam. Lindquist (2009) notes that a growing number of unmarried women are going on *merantau* as women increasingly become heads of households and are expected to support their families. Many women see Batam as an ideal location for *merantau* because of the feminization of labour on the island, and "ideally hope to gain access to the economy of development before returning home successfully" (Lindquist, 2009, p. 11). While migration is partially driven by an increase in feminized labour and the sex industry, it also drives the feminization of these sectors as the social role of women changes in Indonesian society and families.

This relates directly to the prevalence of remittances in the lives of many female migrants. Remittances were central to Dewi's experiences in Batam. While talking to her mother on the phone about sending money home, she says "I'm dizzy thinking about it. It's driving me crazy, Mom, I wasn't able to sleep last night thinking about it" (Dalzell et al., 2005, 08:10). Remittances allow women who travel abroad to feel like "good mothers and dutiful daughters" by providing for their families but can be sources of *malu* when women do not meet their families' expectations (Ford & Lyons, 2008, p. 186; Lindquist, 2004). This makes engagement in sex work a double-edged sword for some women in terms of their family—they would feel *malu* if their families knew about their work but would also feel *malu* if they were unable to provide for their families and so must engage in sexual labour. Female experiences of *malu* become "the emotional link between the village or home... and the space of migration" as sex workers navigate their complex relationships with home and family (Lindquist, 2004). The prevalence of remittances in the lives of female migrants shows that the sex industry in Batam is not solely the result of broader forces of economic development—it is also sustained by women's need to support their families abroad.

While all women come to Batam with varying familial experiences and obligations, some sex workers forge new transnational relationships through their labour to move through social classes. Interested in the intersection of class and the experiences of sex workers in the Riau Archipelago, Ford and Lyons (2008) follow the lives of Ani and Lia, two women who wanted to leave the sex industry but continued to engage in sex work to support their families abroad via remittances. Both women eventually met Singaporean men and "married out" of their work to achieve class mobility (Ford & Lyons, 2008). These women were able to continue to support their families through their marriages and achieve class mobility by dissociating from sexual labour and securing more stable earnings (Ford & Lyons, 2008). The experiences of Ani and Lia show that sex workers and the sex industry in Batam are not only acted upon by Singaporean capital and male tourists. In their transactions with Singaporean men, sex workers strategically use their sexual labour as a means of class mobility and a form of resistance to the structural barriers they face in Batam.

It is important to note that the experiences of individual sex workers will vary greatly depending on their race, class, and mobility. Women's individual lived experiences and circumstances will shape their experiences of *malu*, their relationships with their families, and their feelings towards their labour. However, this analysis of certain experiences at the scale of the body and the family provides a useful counterpoint to the narrative that the growth of the sex industry is only the result of broad economic structures that operate between nations. The industry is also deeply influenced by cultural values, familial expectations, and the lived experiences of individual sex workers who act with constrained agency to not only support their families, but also to exert influence on their industry, nation, and region.

Conclusion

The sex tourism industry in Batam is the result of much more than a simple dyadic relationship between Singaporean capital and local development. The lived experiences of sex workers like Dewi, Ani, and Lia show that the industry is also influenced by obligations to transnational families and individual experiences of precarity. However, it is still important to consider the broad economic forces that seek to capitalize on and restrict the mobility of sex workers. The complex power dynamics between Singapore and Batam, and the regulation of the sex industry by the Indonesian state, demonstrates how the rhetoric of “borderless” development can increase the marginality and surveillance of certain bodies in the global economy. These differing scales of analysis exist in relationship to each other and shape the feminization of labour migration and the increased need for women to work in the sex sector to secure liveable wages and support transnational families. Ultimately, this analysis of sex work in Batam demonstrates the importance of supporting women who engage in sex work while simultaneously attempting to dismantle structural barriers which constrain their ability to make completely free choices regarding their labour and their bodies.

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METIS SCRIP CERTIFICATES AND THE MANITOBA ACT OF 1870: A NARRATIVE OF DISPOSSESSION AND RESILIENCY

By Grace Van Der Velden

The purpose of this paper is to examine the Manitoba Act of 1870 as a measure of settler colonial dispossession. This paper will study how the Manitoba Act forcefully displaced the Metis from their land for the creation of the province of Manitoba. The Metis are an Indigenous nation of European and Indigenous heritage, with a distinct and independent culture. The Manitoba Act and the associated scrip certificates imposed a colonial rule of law on Metis communities, with the purpose of removing their Indian status, severing their ties to other Indigenous nations, and dispossessing them of their nation's culture and lifeways, which were all perceived as a threat to the Canadian government. By examining the legal language of the Act and land scrips, it is clear that the Canadian government attempted to conceal displacement and dispossession through a purposefully unclear administrative process. Additionally, the process was placated by the supposed "gifting" of land to the Metis for revoking their Indian status. This colonial imposition set the tone in Metis-settler relations.

Introduction

The purpose of this paper will be untangling the complex layers that dispossessed the Metis nation from their land, enacted through settler colonial legal means. I will approach this discussion through the lens of this quote from Harris, "The experienced materiality of colonialism is grounded, as many have noted, in dispossessions and repossessions of land" (2004, p. 167). The ongoing dialectic between dispossession and repossession of land provides a framework to interpret the Metis struggle. This dialogue also details how their identity is intricately linked to their shared sense of place, or lack of place, as their nationhood was challenged by settler colonialism. I will use the Manitoba Act of 1870, which created Manitoba as a province, and the scrip certificates that were part of the Act and allocated either plots of land or money to Metis individuals, to explain the process of dispossession. Through this analysis, I assert that colonial legal language utilized in the Manitoba Act of 1870 and the associated land scrip certificates held the intention of both the placation and eradication of the Metis people. Using the primary sources of the Manitoba Act of 1870 and an example of scrip, I will analyse how the Canadian government imposed unilateral legal decisions on the Metis without their full consent or knowledge, and how this confusing relationship between the law and access to the land would set precedent for how the Metis dealt with growing settler presence on their land.

I will first provide a brief understanding of who the Metis are, explaining their unique “hybrid” identity. This will be followed by an examination of the historic and temporal context under which the Manitoba Act of 1870 arose, and under which circumstances the introduction of the scrip land certificate system was initiated. As this context is established, I will begin to untangle the dominant attitudes, strategies, and language deployed by the settler colonists in working to dispossess the Metis of their land and identity. In summation, I will show how the colonial agents of the Canadian government used their own legal system to accompany the violence and brute force enacted against the Metis with the underlying intention of clearing them from the land.

The Metis People: Land and Identity

It is important to understand the context under which the Metis arose as a people. The Metis people were borne of European contact and intermarrying with Indigenous groups, and represented a much more harmonious relationship between diverse cultures than the subsequent white colonial settlement and establishment of Manitoba as a province. The Metis nation and identity emerged after two centuries of fur trade. As Taylor (1983) explains, the Metis “...formed a coherent society of their own with a strong group consciousness...” (p. 153). Teillet describes their culture as “a unique response to the land” on which they lived (2011, p. 24). The hybridity of their culture is exemplified in the “creative mixing of Amer-Indian and Euro-Canadian customs, languages, and traditions” (Teillet, 2011, p. 24), and does not rest on the domination of one over the other.

As a nation, Metis followed lifeways more similar to their Indigenous ancestors than of their European ancestors. They were an independent nation, with a strong sense of nationhood, and did not wish to be treated as synonymous with other Indigenous groups (Taylor, 1983, pp. 153-154). The Metis, as a nation, were proof that settler and Indigenous populations could live in harmony, sharing and taking care of one another out of profound respect and close familial ties, based on practices of cooperation.

Colonial Legal Documents

I will now introduce the legal texts that were targeted at destabilizing Metis nationhood and their relationship to the land: The Manitoba Act of 1870 and an example of a scrip certificate that delegated land to qualifying Metis and “half-breed” recipients. The two of these together were used as legal weapons against the Metis identity and their connection to the land. At the heart of the language used in these colonial documents was dispossession and the intention of clearing and priming the land for European settlement.

The Manitoba Act of 1870

And whereas, it is expedient, towards the extinguishment of the Indian Title to the lands in the Province, to appropriate a portion of such ungranted lands, to the extent of one million four hundred thousand acres thereof, for the benefit of the families of the half-breed residents, it is hereby enacted, that, under regulations to be from time to time made by the Governor General in Council, the Lieutenant-Governor shall select such lots or tracts in such parts of the Province as he may deem expedient, to the extent aforesaid, and divide the same among the children of the half-breed heads of families residing in the Province at the time of the said transfer to Canada, and the same shall be granted to the said children respectively, in such mode and on such conditions as to settlement and otherwise, as the Governor General in Council may from time to time determine (Manitoba Act of 1870).

Here, I provide Section 31 of the Manitoba Act of 1870, which was viewed as particularly contentious. The Manitoba Act of 1870 set precedent for the introduction of the scrip certificate system, which became a legal, although unlawful (O'Toole, 2015, p. 82), means for the Government of Canada to delegate tracts of land to Metis families, and at the same time dispossess them of their land. This dispossession was seen as essential by the Canadian government, as the Metis held strong ties to other Indigenous groups in the region, which the government interpreted as a major threat (Taylor, 1983, p. 156). Many academics and legal professionals agree that the Manitoba Act was a “unilateral action of the Canadian Parliament, not a treaty between independent partners” (O'Toole, 2015, p. 82). However, the Canadian government took the position that it was acting as a “benevolent” (Tough & McGregor, 2007, p. 38) caretaker by offering scrip to the heads of Metis families, under the condition that they relinquished their Indian Status. This convoluted and twisted sense of “generosity” on the part of the colonial agents is reflected in the language used in the Manitoba Act, which is malicious in its nature towards Metis nationhood, land practices, and identity (Tough & McGregor, 2007, p. 38). Here, it is clearly illustrated what kind of colonial vocabulary was utilized against the Metis, and how the Government of Canada asserted power by writing laws within their own legal system, without consulting the legal or ruling laws of the Metis or other Indigenous groups. The use of the word “extinguishment” in the first sentence of Section 31 reveals the most clearly the intention of eradication. The language also inherently disagrees with and disallows Metis sovereignty, as it explains that their new settlement on this 1.4 million-acre tract of land is meant to be specifically delegated and determined by the Governor General.

Metis and Indigenous legal systems are centred on consensus and justice stemming from a connection to the land. In contrast, while settler colonial legal systems are centred on a hierarchy of power and top-down processes (Teillet, 2011, p. 171). The Manitoba Act and its unilateral legal imposition exemplifies these differences in worldview and perspective. The political geography of Canada that we know today, particularly the prairie provinces, was largely determined by these Eurocentric “legal” processes, and the colonial language they weaponized against the identity of the Metis nation. Section 31 was neither a land claim nor a treaty but was established to set precedent for the creation of Manitoba as a province (O'Toole, 2015, p. 112).



Figure 1 Example of a Metis Scrip General transcription: “The Bearer hereof is entitled to an allowance of One Hundred and Sixty Dollars in any purchase of Dominion Lands. Issued at the Department of the Interior at Ottawa, twenty ninth day of January, 1901. Authorised by an Order of His Excellency the Governor General-in-Council...” (Saskatchewan Archives Board)

Metis Scrip

Section 31 of the Manitoba Act provided legal context for the subsequent delegation of scrip and land grants. The image and transcription provided above is just one of several thousands of scrip certificates that were issued to Metis individuals from the 1870’s to the 1920’s (Our Legacy, 2008). Scrip was a tool created and weaponized by the Canadian government to strip individuals of their Metis title. The language used on the certificate implies that the Government of Canada is being generous in “gifting” the scrip receivers with a large tract of land. In referring to the region included in the scrip certificates as “Dominion Lands,” settlers claimed ownership over land that they had only known for a few decades; land that Metis communities and their Indigenous ancestors had called home since time immemorial. The legal jargon used here was intentional in its efforts to erase, dispossess, and force the expulsion of Metis people from their ancestral lands. Official government policy demanded that individuals retract their Indian Status to be eligible for Metis Scrip. This reflects the Canadian government’s attitude towards regulating and legally binding the ethnicity and identity of Indigenous people, which acted as a tool of colonization.

Metis scrip certificates, in their physical paper form, reveal the intent of the Canadian Government at the time. As an institution, the government and colonial agents distributing the scrip regarded the Metis as a nuisance that needed to be displaced from prime lands for settlement purposes. Teillet is clear to point out that “scrip was the means by which the government of Canada distributed lands to groups of people it wished to reward or pacify” (2011, p. 109). Considering the weight (i.e. 160 acres of land or \$160) that each scrip certificate represented, the example provided above offers scant information about the full proceedings that were to take place. Tough and McGregor (2007) discuss how convoluted the scrip system was, as it was not always clear how the land or money was to be administered. Additionally, several people impersonated Metis to receive scrip, which delegitimized the entire project. This convolution can be seen as a tool of the colonial government to confuse, distract, and impose a new rule of law on Metis communities (Tough & McGregor, 2007). As well, by looking at the simplicity of a scrip certificate, we can understand how the government of Canada used these pieces of paper to diminish and regulate Metis identities, land practices, and lifeways. In the establishment of the scrip system, Metis individuals were reduced to numbers, small plots of land, and items in a record book, rather than people. This reductionist approach on the part of the government, including the derogatory “half-breed” labelling of Metis peoples, was deliberate in its attempt to undermine their identity, rooted in a deep connection to the land.

Colonial Language, Attitudes, and Strategies of Dispossession

The creation of the Manitoba Act of 1870 and the system of scrip can be interpreted as a calculated attack on Metis nationhood and identity. As poignantly explained by Blomley, "... it has been argued that the legal system not only facilitated dispossession but also concealed, legitimized, and depoliticized that process, attributing "to the new land arrangements an aura of necessity and naturalness that protects the new status quo and prevents further redistribution" (2004, p. 111). Further, we see colonialism as a process "informed by the precepts of political economy and historical geography" (Tough & McGregor, 2007, p. 54). With the arrival of European settlers and the colonial powers, came the arrival of European conceptions of property. Imposing their conceptions of property was a colonial project, an imported social construct, not an idea that was agreed upon by the Metis who suddenly found themselves subject to this new way of thinking (Tough & McGregor, 2007, p. 55). Metis individuals were pigeonholed into a situation in which they faced very little choice. For many, accepting scrip and renouncing their Indian status presented itself as a "better than nothing" situation (Niemi-Bohun, 2009). Many Metis chose to take the money rather than land and fled west-ward amidst growing missionary and settler presence in the regions where their scrip land was located. In doing so, Indian title was effectively extinguished (Niemi-Bohun, 2009, p. 85), which can be seen as the goal all along by the colonial Canadian government.

In their 200 years of establishing a culture and people, the Metis maintained fluid ideals of nationhood and identity, not predicated on terms like "half-breed" or hierarchical ethnic identification based on how "white" an individual was. One of the strategies used by colonial agents and the colonial government to dismiss the existence, uniqueness, and strength of the Metis culture-community was the narrow system of racial categorization. Colonial agents created categories of people (i.e. "Indian" or "half-breed") to pay individuals accordingly, either in money or land, and "pacify" them (Teillet, 2011, p. 109). These categories reflect colonial institutions' efforts to exert power by maintaining ethnic identities or cultural groups. These were then used as administrative categories by the colonial agents, with the goal of clearing the land for further white settlement, with little concern for the implications these narrow "boxes" of identity might have for future generations of Metis. Both the scrip system and Section 31 follows the colonial attitude of seeing land transfers as nothing more than "real estate transactions" (O'Toole, 2015, p. 113), ignoring the complex cultural ties and Metis identity rooted in the land.

Conclusion

As I have demonstrated here using the examples of the Manitoba Act of 1870 and the scrip certificate, the project of colonial settlement was propelled by legal texts and processes that worked beyond and outside the systems of law of the people they attempted to dominate and displace. This analysis shows that the Metis were subjugated to same process. It is clear that the Canadian government never intended to establish a relationship with the Metis on equal footing, which is demonstrated by the language utilized in Section 31 of the Manitoba Act. The materiality of the scrip certificates bolstered this colonial project, initiating a beneficiary relationship in which they held power over the Metis through a purposefully confusing administrative process. Together, the evidence I have provided shows that the Canadian government always intended to scatter and weaken the Metis through legal mechanisms. In summation, we can see that this "benevolent" relationship was a self-serving project carried out by the Canadian government, intended to placate, disperse, and destabilize the Metis sense of place, identity, and nationhood.

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THE IMPLICATIONS OF IMPERVIOUS SURFACES FOR FLOOD MANAGEMENT IN THE GTA

By Monica Iqbal

This paper examines how impervious surfaces increase the amount of runoff from precipitation in the GTA. Impervious surfaces cannot handle heavy precipitation, and the prevalence of such surfaces increases the likelihood of flooding in Toronto and other urban areas. Climate change has heavily influenced the frequency and intensity of storms in the GTA and the rest of Canada, substantially increasing urban runoff in both cases. This paper also examines many well-researched solutions that have the potential to address this issue, although many of them tend to focus on flood mitigation. Future recommendations include implementing reservoir flood storage systems, green roofs, water plazas, and detention reservoirs.

Introduction

Before urbanization, there existed abundant pervious surfaces, including trees and plants. These surfaces were capable of dealing with massive amounts of rainfall by absorbing water through processes such as percolation, infiltration, and interception. Eventually, urbanization largely replaced pervious surfaces with impervious ones. Examples of impervious surfaces include roads and pavement. Unlike pervious surfaces, they cannot absorb water, which leads to greater amounts of runoff developing. Therefore, urbanization, as well as other factors such as climate change, sharply increases the risk of floods (McLeman & Smit, 2006). Because Toronto is a large metropolitan area, it is particularly susceptible to flood risks due to urbanization (Nirupama & Simonovic, 2006).

The frequency of storms in Toronto, as well as the rest of Canada, is increasing due to climate change (Sandink, 2015). As storms become more frequent and intense, greater amounts of urban runoff will develop because there are abundant impervious surfaces. This ultimately leads to flooding. Existing sewers that are used for stormwater collection cannot carry large amounts of water, which also leads to floods. Current flood management solutions focus on mitigation (Muste, 2018), but urban planners and politicians need to consider changes to the capacity of the current sewage system because impervious surfaces are incapable of absorbing water, and existing sewers are not large enough. They should also consider protection of existing permeable surfaces and conversion of impermeable to permeable surfaces in order to help with eliminating runoff, and finally, more proactive measures to address climate change because it increases the frequency and intensity of storms.

This paper has two objectives. First, I will examine the consequences of floods in the GTA because understanding them will help determine to what extent the rise of impervious surfaces, in combination with increasing storms, will risk overflowing Toronto's sewer system. More specifically, I will explore the history of Toronto's floods. Toronto has experienced four major floods to date: 1954, 1976, 2005, and 2013 (Nirupama, Armenakis, & Montpetit, 2014). I will discuss the sources and outcomes of each of these floods. I will look at which of the known flood impacts could have possibly originated from impervious surfaces for each of these floods.

The second objective is to evaluate current solutions and propose future recommendations for flood management to address the dual problem of an increase in both storms and impervious surfaces. Several measures have been taken, notably flood mitigation (Muste, 2018). One example is flood risk mapping in Toronto based on the current population, economic development, and key infrastructure (Armenakis & Nirupama, 2014).

Study Area

Prior to conducting a detailed analysis of the roles that impervious surfaces play on flood management, I will provide some background information on the geography of Toronto. The city is the largest in Canada with approximately 2.5 million residents and a size of 630 km² (Nirupama et al., 2014). The Greater Toronto Area (GTA) has a size of 7,100 km² and a population of approximately 5.5 million (Nirupama et al., 2014). Toronto is the most populated city in Canada and is close to Lake Ontario, the largest surface water system in the world, which acts as a watershed to where a number of rivers, lakes, and creeks flow (Nirupama et al., 2014). Lake Ontario is also directly impacted by air masses coming from the Gulf of Mexico, the Atlantic Ocean, and the Arctic (Nirupama et al., 2014). As a result, Toronto is vulnerable to floods and other extreme weather events (Nirupama et al., 2014). Toronto and the GTA are located between the Don River and Humber River watersheds, both of which drain into Lake Ontario (Armenakis, Du, Natesan, Persad & Zhang, 2017). Other watersheds of the GTA include the Etobicoke and Mimico Creeks (Figure 1).

Impervious surfaces make up 73% of the GTA, a feature that makes the area vulnerable to floods (Rincón, Khan & Armenakis, 2018). For instance, the Don River is prone to floods due to its

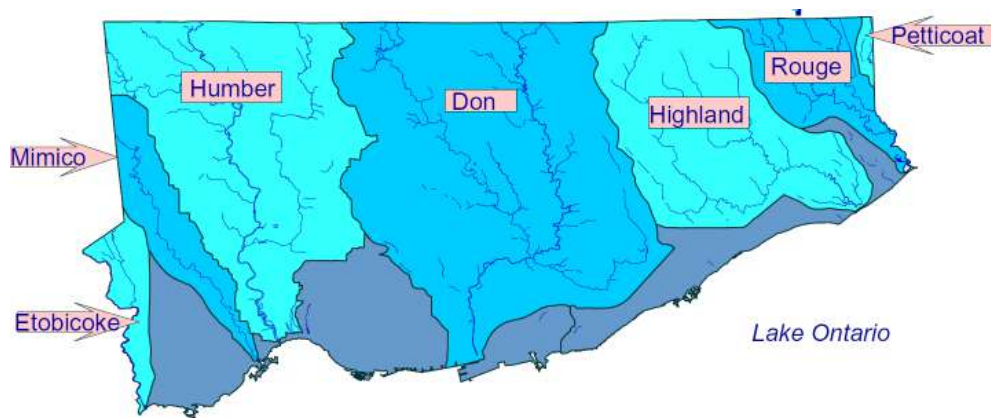


Figure 1 A map of the Greater Toronto Area and its watersheds. From “Toronto Watershed Map” (Evergreen Tour Guide Wiki, 2012).

urbanized nature; small amounts of rainfall can rapidly elevate the water level (Nirupama et al., 2014). This is because the Don River Valley is 400m wide, but the river itself is only 15m wide (Nirupama et al., 2014). To exacerbate issues with impervious surfaces, Toronto's topography is quite smooth, starting at 75m at Lake Ontario above the water and ending at a 209m elevation in the North York area of Toronto (Nirupama et al., 2014). Flat slopes can lower the velocity of surface runoff, ultimately requiring more time for urban runoff to drain (Rincón et al., 2018). Flat slopes therefore constitute a form of impervious surface. Du, Shi, Van Rompaey and Wen (2015) state that replacing vegetation with impervious surfaces results in a decrease in transpiration, soil evaporation, and overall infiltration, and more urban runoff is generated when this happens.

Analysis

In this section, I will provide an analysis of impervious surfaces and flood management based on the objectives I have defined in the introduction. This section will contain three subsections: the history of floods in Toronto and the role that impervious surfaces played in all of them, the types of flood impacts on the city that are directly related to such surfaces, and the evaluation of current and potential solutions that address the rise of impervious surfaces and storms.

History of major floods in Toronto

The first major flood of Toronto occurred in 1954 as a result of Hurricane Hazel (Nirupama et al., 2014). The impacts were profound; 81 people died and 7,472 were left homeless after 210 mm of rain fell over the span of two days (Nirupama et al., 2014). The severity of the flood peaked in low-lying areas of the Don and Humber Rivers as well as the Etobicoke and Mimico Creeks (Nirupama et al., 2014). The Etobicoke Creek itself is urbanized and heavy infrastructural damage occurred, a first for the city at the time (Erechtchoukova, Khaiteh & Saffarpour, 2016). Twenty bridges were damaged or knocked down, with many homes completely destroyed (Nirupama et al., 2014). The flood was so severe that it shifted automobiles, trailers, cottages, and homes toward the strong current (Robinson & Cruikshank, 2006).

The next flood occurred in 1976. Two massive storms over the course of two days resulted in 75 mm of rainfall (Nirupama et al., 2014). Important infrastructure, such as bridges, was directly impacted as in the 1954 flood (Nirupama et al., 2014). The flood cost \$1.3 million in damages (Nirupama et al., 2014).

On August 19, 2005, 153 mm of rain fell over the span of three hours (Nirupama et al., 2014). The storm was so strong that flooding occurred in the Don Valley for a short period of time (Nirupama et al., 2014). Power outages affected about 10,000 residents, and there were over 1,200 cases of flooded basements (Nirupama et al., 2014). The flood became Ontario's most expensive natural disaster, resulting in \$500 million in damages (Nirupama et al., 2014). Creeks, rivers, and ravines were flooded, leading to bank erosion as well as damage to sewer backups and key infrastructure (Nirupama et al., 2014).

The most recent major flood happened on July 8, 2013. It was caused by a heavy storm yielding extreme rainfall that had major impacts on the city. Thousands of homes in the GTA were flooded (Sandink, 2015). The intensity of the storm varied by area; parts of the GTA received around 90mm of rain (Nirupama et al., 2014), while other areas received over 100 mm of rain (Nirupama et al., 2014). At Pearson International Airport, over 126 mm of rainfall was reported, well above

the monthly average of 74.4 mm (Nirupama et al., 2014). 300,000 people in the GTA were left without power on that day (Nirupama et al., 2014). Flight cancellations and subway closures were among the serious disruptions that occurred as a result of the flood (Nirupama et al., 2014). Property damage from this flood exceeded \$850 million, surpassing that of the 2005 flood (Nirupama et al., 2014).

How did impervious surfaces contribute to each of these floods? The GTA's population has grown 700% since 1931, and more than 75% of the GTA has undergone urban development (Rincón et al., 2018). More urbanization implies more impervious surfaces and greater runoff rates (Rincón et al., 2018). For example, Etobicoke Creek was one of the major watersheds that flooded in 1954 (Nirupama et al., 2014). According to Erechtkhoukova et al. (2016), the Spring Creek, a tributary of Etobicoke Creek, is heavily impervious, leading to rapid runoff responses to extreme rainfall.

Impervious surfaces and their impacts on floods

When urbanization increases, so does the number of impervious surfaces. Runoff rates therefore increase substantially, especially during periods of extreme rainfall (Rincón et al., 2018). Nirupama and Simonovic (2006) state that urbanization reduces infiltration in addition to increasing the number of impervious surfaces. Moreover, according to the Intergovernmental Panel on Climate Change (IPCC), heavy precipitation due to climate change increases the likelihood of flood events (McLeman & Smit, 2006). Excess water that rivers are unable to carry overflows river banks and fills nearby, low-lying lands (Rincón et al., 2018). This is known as river flooding, one of the costliest and most frequently occurring natural disasters (Rincón et al., 2018). The limited storage capacity of rivers makes extreme rainfall a primary driver of such flooding (Rincón et al., 2018). Erechtkhoukova et al. (2016) state that in urbanized watersheds with impervious surfaces, storm-water runoff causes stream water levels to rise, also contributing to river floods. The 1954 Toronto flood reflects this phenomenon, with the Don and Humber Rivers being filled beyond capacity. Since the Don River watershed is heavily urbanized (Nirupama et al., 2014), it is prone to increasing stream water levels from heavy precipitation as Erechtkhoukova et al. (2016) state. Similarly, transforming watersheds from rural to urban watersheds generates consequences such as flooding and erosion (Bocking, 2006).

River floods in particular cause damage to agriculture and infrastructure, death, the spread of diseases, and water supply contamination (Rincón et al., 2018). In the 2005 flood, flooded rivers notably caused bank erosion and infrastructure damage (Nirupama et al., 2014). Negative impacts of floods increase with soil saturation, high suspended matter, and landslides (Rincón et al., 2018). Basement flooding, among other flood types, results from negative flood impacts (Sandink, 2015).

Soil saturation, which occurs when soils cannot absorb any more water, can be linked with impervious surfaces. For example, the Thames River watershed in London, Ontario consists of impervious clay soils that increase runoff rates, thereby making it susceptible to floods (Nirupama & Simonovic, 2006). The Soil Conservation Services (SCS) developed a parameter known as the Curve Number (CN) to estimate the level of runoff or infiltration from excess rainfall (Rincón et al., 2018). The CN takes into consideration soil type and land use (Rincón et al., 2018). A high CN is associated with impervious surfaces, meaning high runoff and low infiltration (Rincón et al., 2018). In contrast, a low CN is assigned to soils that produce very little runoff and therefore indicates low runoff and high infiltration (Rincón et al., 2018). Because of urbanization (i.e. adding impervious surfaces), there are no soils to infiltrate precipitation.

Different flood types are worsened by impervious surfaces. Sandink (2015) lists three types of floods that can occur in ground-related homes as a result of extreme rainfall: infiltration, stormwater, and sewer backup. Infiltration flooding is a well-known cause of basement flooding (Sandink, 2015). This occurs when groundwater levels surpass the lowest level of basement floors (Sandink, 2015); water then seeps through cracks found in the foundation wall and eventually enters the home (Figure 2). Stormwater flooding is the result of stormwater flows exceeding the capacity of stormwater management systems and moving towards the home (Figure 3). Finally, sewer backup flooding happens when underground public storm and/or wastewater systems surcharge, ultimately leading to sewage flowing towards the home via a private sewer connection (Figure 4). Sewer backup flooding can occur in either combined or separated sewers (Sandink, 2015). In particular, they are related to increased urbanization (Sandink, 2015). For instance, one of the impacts of urbanization on urban hydrology is that there are more peak stormwater flows during periods of rainfall (Sandink, 2015).

Combined sewer overflows are another major contributor to floods. Combined sewer overflows result in wet weather flow discharges, ultimately leading to floods (D'Andrea, Snodgrass & Chessie, 2004). By impervious paving as well as installing sewers and storm drains, runoff routing becomes smoother and there becomes very little lag between precipitation and peak discharge (Du et al., 2015).

Solutions and future recommendations

After the Hurricane Hazel flood in 1954, conservation authorities began to develop more flood control and flood management options (Bocking, 2006). Various solutions have been developed to manage floods, although many of them focus on flood mitigation, such as flood risk mapping. The motivation behind creating flood risk maps comes from risk assessment, defined as: how methodologies can be applied to determine the risks from hazards and exposures to an event as well as impacts of that event (Armenakis & Nirupama, 2014). It can map areas based on impervious surfaces and other factors. Armenakis and Nirupama (2014) use GIS (Geographical Information System) technology to develop flood risk maps, evaluating the following factors: terrain slope, drainage networks, land depression, and demographics. Putting all these factors together, a flood risk map for the entire GTA can be developed (Figure 5). Using GIS technology for spatial modelling and visualization allows for the prioritization of flood risk areas (Armenakis & Nirupama, 2014). This helps create specific strategies that reduce flood impacts and increase the effectiveness of flood management, as the maps can help decision makers visualize flood-prone areas (Armenakis & Nirupama, 2014).

However, flood maps alone are insufficient in determining the risks to people, property, infrastructure, and services (Armenakis et al., 2017). To expand on the development of flood maps as a solution, Armenakis et al. (2017) suggest creating enhanced flood maps by using high spatial resolution earth observation (EO) data. This generates and updates existing flood maps based on population, economic development, and critical infrastructure, ultimately improving a city's flood mitigation and preparedness strategy. A suggested approach was to combine flood maps, socio-economic factors, and impacts on infrastructure and services (Armenakis et al., 2017). The GTA was used as a case study to test the proposed methodology by developing an enhanced flood map (Figure 6). Impervious surfaces were incorporated into these maps through the flood hazard spatial layer (Armenakis et al., 2017). Armenakis et al. (2017) take into account impervious surfaces among other areas that are prone to flooding. Spatial impact weights, such as areas of water concentration, are

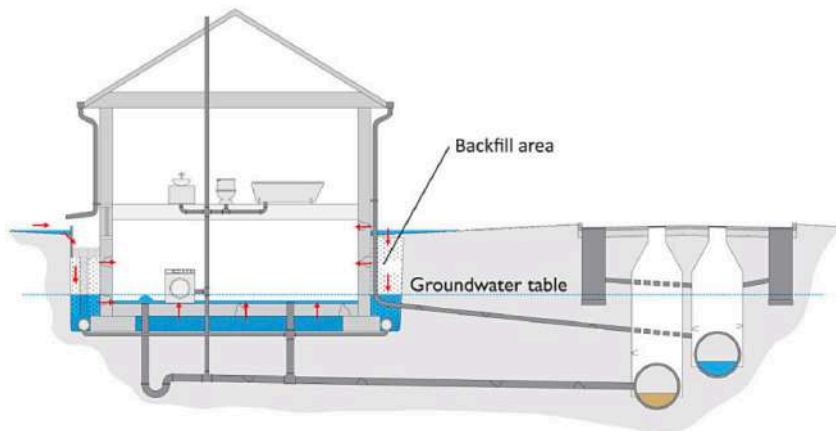


Figure 2 Infiltration flooding in homes (Sandink, 2015, p. 210).

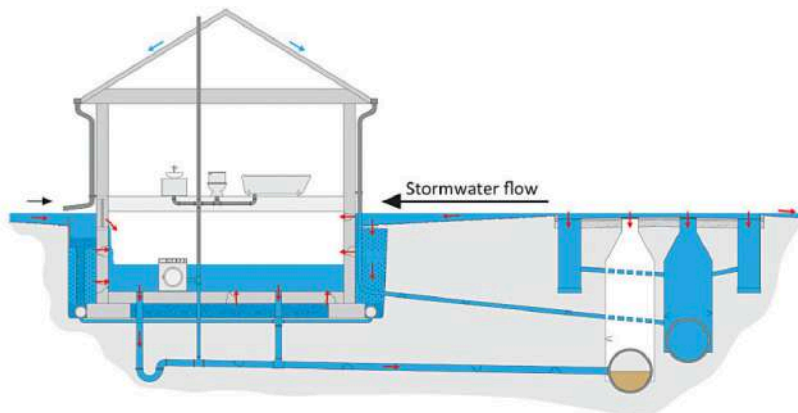


Figure 3 Stormwater flooding in homes (Sandink, 2015, p. 210).

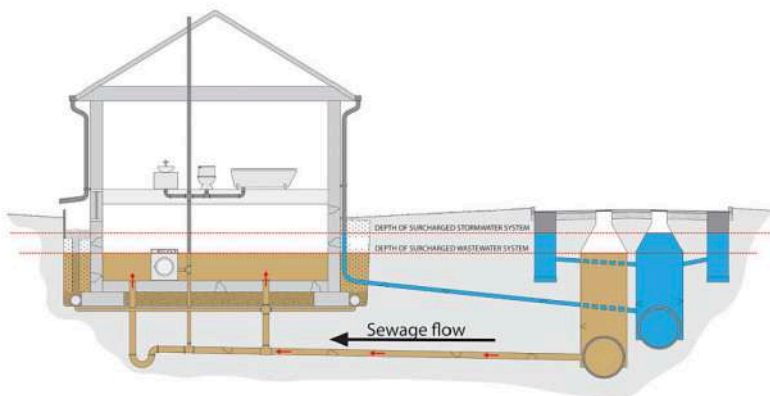


Figure 4 Sewer backup flooding in homes (Sandink, 2015, p. 211).

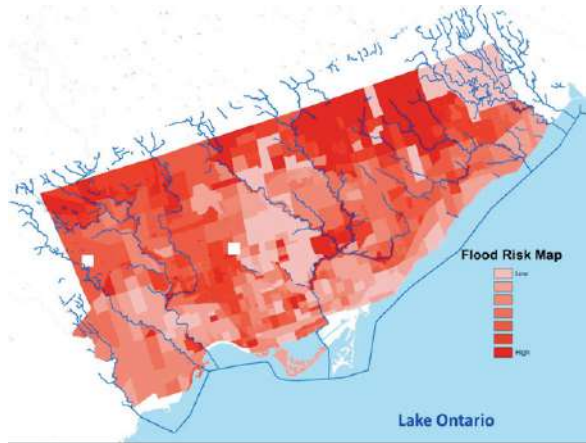


Figure 5 Flood risk map for the GTA to map the risk of floods based on population data and topography (Armenakis & Nirupama, 2014, p. 325).

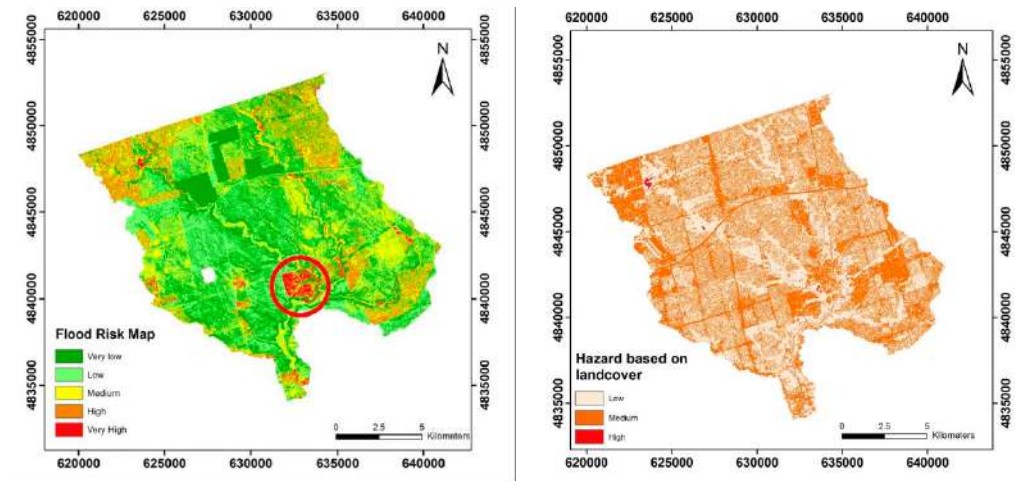
assigned to the layer (Armenakis et al., 2017). Figure 7 shows a flood hazard area map that was developed based on impervious surfaces, vegetation, water, bare soil, and grasslands.

Mann and Wolfe (2016) propose that flood mitigation on a smaller scale could be beneficial to reduce flood risks and impacts. Some examples of strategies include having homeowners take careful measures at the lot level and making use of effective risk communication tools (Mann & Wolfe, 2016). These types of strategies can be associated with impervious surfaces. One such example is the implementation of user charges being allocated to the amount of imperviousness of an individual lot (D'Andrea et al., 2004). To support the City of Toronto's Wet Weather Flow and Management Plan, a stormwater public education and community outreach program has also been developed to promote the reduction of impervious surfaces (D'Andrea et al., 2004).

But how effective are these flood mitigation strategies? According to Mann and Wolfe (2016), effectiveness depends on personal beliefs that individuals hold about floods.

Infrastructure solutions with respect to impervious surfaces have also been on the agenda for flood management in Toronto. In 2007, construction in the West Don Lands in downtown Toronto started, with civil engineering projects for flood protection and other purposes in mind (Bellas & Oliver, 2016). Parks and open green spaces that were developed in the area had great potential to control floods and ultimately benefit the Don River Park (Nichols, 2009). The addition of these green areas also addressed the problem of impervious surfaces, which are unable to control floods. The Don River Park was proposed to bring environmental benefits through flood control, since pervious surfaces are capable of absorbing water (Nichols, 2009). Additionally, one member of the Waterfront Toronto project has stated that flood protection infrastructure is under development in the Port Lands, one of Toronto's remaining slices of publicly-owned waterfront real estate (Bellas & Oliver, 2016).

There are several possible directions that Toronto can take with respect to flood management. The state of California, USA, is well known for its flood management and has implemented a reservoir flood storage system (Lund, 2012). Nearly all of California's major reservoirs have a seasonal flood



Figures 6 & 7 GTA flood risk map based on total flood hazard and vulnerability (Armenakis et al., 2017, p. 11); GTA flood hazard area map that is based on impervious surfaces and other land cover areas (Armenakis et al., 2017, p. 9).

management pool to decrease the amount of peak flows from storms (Lund, 2012). I suggest that Toronto follow in the footsteps of California and implement a reservoir flood storage system that would be capable of carrying large amounts of water from storms.

To a certain extent, the motivation behind California implementing reservoirs as a flood management solution comes from impervious surfaces. Moura, Pellegrino, & Martins (2015) state that impervious surfaces increase the amount of runoff, resulting in negative impacts on drainage systems with a greater risk of flooding. Impervious surfaces are incapable of handling large volumes of water; this ties in drainage systems, but such systems often have a limited carrying capacity. Infrastructure, such as separate sewers, is also prohibitively expensive. Detention reservoirs therefore constitute sustainable investments that have been proven to be effective in eliminating floods in urban watersheds found in Greater Sao Paulo (Figure 8; Moura et al., 2015). I recommend that Toronto build a detention reservoir near its urbanized watersheds, such as the Don River. I believe that this should be a priority because of the area's urbanized nature and demonstrated vulnerability to floods.

Jonkman and Dawson (2012) mention water plazas and green roofs that are implemented at the local level to decrease surface water runoff. Urban areas are one of the most compelling cases when it comes to implementing flood risk management technologies because of the abundance of impervious surfaces (Jonkman & Dawson, 2012). Once again, this solution can be linked to these surfaces. The purpose of these solutions is to decrease runoff, but impervious surfaces and urbanization only increase runoff, especially during times of heavy rainfall (Moura et al., 2015). I believe that implementing green roofs in the West Don Lands area of Toronto would be an ideal option because of its proximity to the Don River, a flood-prone watershed. Since flood infrastructure development is underway in the Port Lands (Bellas & Oliver, 2009), it would also be a good idea to implement these features there.



Figure 8 A detention reservoir in Sao Paulo that is used for flood control (Moura et al., 2015, p. 247)

Toronto must protect existing green spaces from being converted to impervious surfaces, as this only increases the likelihood of flood events occurring. Protecting the transformation of certain areas to other uses (ex: transforming open land to urban areas) is important, as emphasized in a survey conducted by the Don Valley Conservation Authority (Bocking, 2006). This protection can be emphasized through the development of local or governmental policies. Through transforming pervious to impervious surfaces, watersheds such as the Don River could experience more flooding and erosion (Bocking, 2006).

Du et al. (2015) propose an index called the Impervious Surface Impact Index (ISII) to assist in finding appropriate locations for urban development while reducing the impact of urban development on flood risks. The index quantifies the impact of impervious surfaces on floods (Du et al., 2015), and a greater ISII corresponds with greater urban runoff and vice versa (Du et al., 2015). Areas with low ISII values are more suitable for urban development, while areas with high ISII should not go through development at all (Du et al., 2015). I strongly believe that Toronto should take this into consideration and use the index to determine appropriate urban development areas at the local level.

Conclusions

Flood risk is rapidly increasing due to climate change. Existing sewers have a limited carrying capacity, and excess water from extreme rainfall cannot be absorbed by impervious surfaces, thereby increasing the rate of stormwater runoff (Rincón et al., 2018). Most of the GTA consists of impervious surfaces, and the four major floods experienced by Toronto provide evidence of its vulnerability. However, it is not only existing sewers that are incapable of handling large amounts of water; urbanized watersheds such as the Don River watershed are prone to flooding. River floods also occur frequently and have devastating impacts, such as death, damage to infrastructure, disease outbreaks, and flooding in ground-related homes.

Currently, there are several flood management solutions, though many focus on flood mitigation. A notable example of a flood mitigation solution is flood risk mapping; GIS technology is used to map out specific areas of the GTA that are especially vulnerable to flooding. Vulnerability is decided based off factors like demographics and topography (e.g. land depression, terrain slope, and drainage networks), as well as impervious surfaces. In flood maps, Armenakis et al. (2017) create a flood hazard spatial layer that maps out impervious surfaces in Toronto, analyzing the impacts that floods have on these surfaces. Infrastructure projects, such as the West Don Lands project, also focus on flood protection through the creation of parks and green spaces. These initiatives attempt to address the issue of impervious surfaces generating greater amounts of runoff. The Don River Park was a proposal that was developed to better control floods in Toronto through adding green spaces (Nichols, 2009).

In the future, urban planners and politicians could look into implementing reservoir flood storage systems similar to those in California or Sao Paulo. In both cases, water plazas and green roofs reduce impervious surface area and aid flood management by reducing surface water runoff. Government policies that restrict the urban transformation of green spaces to impervious surfaces could prove useful. Finally, it is recommended that urban planners and politicians develop an index that calculates the impacts that impervious surfaces have on floods. With this in mind, future developments can be planned appropriately.

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DETERMINING VEGETATION COMPOSITION BETWEEN NORTH AND SOUTH FACING SLOPES

By Jessica Ballie, Conrad Stevens, Elly Verlinden & Justin Moon

Understanding how slope aspect affects vegetation can contribute to greater understanding of local forest dynamics and succession. The aim of the study is to determine if there is a difference in vegetation between two slopes of similar gradients but opposing aspects. This study analysed and quantified forest stand characteristics, understory richness, leaf area index and tree characteristics between north and south facing slopes in a naturally recovering deciduous-coniferous forest in Southern Ontario. *T. canadensis* and *A. saccharum* were dominant species in both aspects, whereas *B. alleghaniensis* was only recorded on south facing slope and *F. americana* and *Q. rubra* were only recorded on north facing slope. The results of leaf area index, tree biodiversity and percentage green cover were all found to not be significant. These results suggest that the close proximity between these slopes may have produced similar environment but solar radiation and other microclimatic factors play a deterministic role in governing vegetation dynamics.

Abbreviations LAI = leaf area index. ePAI = effective plant area index. KSR = Koffler Scientific Reserve. DBH = diameter at the breast height. IVs = importance values. DHP = digital hemispherical photography. NF = north facing. SF = south facing

Introduction

The association between slope aspects and vegetation communities have been described extensively by plant community ecologists. The orientation and steepness of slopes control the amount of solar radiation and microclimate in the forest which influence the soil moisture, air temperature and wind velocity (Del Toro Guerrero et al., 2016; Holland and Steyn, 1975; Hu et al., 2018; Måren et al., 2015; Pook & Moore, 1966; Warren II, 2010) [see Appendix A for calculation of difference in radiation between two studied slopes]. Pook and Moore (1966) and Chapman and McEwan (2016) revealed that south facing (SF) slopes in the northern hemisphere receive more solar radiation compared to the north facing (NF) slopes which promote drier conditions and foster heat-tolerant plant communities. This phenomenon is reversed in the southern hemisphere.

There are numerous studies that attempted to quantify vegetation differences between slope aspects using various models, e.g. in the Himalayas (Måren et al., 2015), China (Hu et al., 2018), Mexico (Del Toro Guerrero et al., 2016) and Australia (Pook & Moore, 1966). Most studies incorporated both on site measurements of canopy and satellite data for the analysis but there is limited knowledge of the understory despite the integrated nature of forest layers (Rogers et. al., 2008). Hu et al.

(2018) stated that measurement-based approaches by sampling plots and utilizing remote-sensing databases may be inappropriate for regional-based studies due to high spatial variability of forest inventory data. Alternatively, the quadrat method is a very simple and inexpensive approach to sampling vegetation (Frédéric et al., 2006).

Data for this paper was sampled from the University of Toronto Koffler Scientific Reserve (KSR) at Joker's Hill is located at 17000 Dufferin St, King City, ON, L7B 1K5 with an elevational gradient of approximately 310 m above sea level. The soils of KSR contain remnants of Oak Ridges Moraine sediments from the former Laurentide Ice Sheet from the Wisconsin glaciation approximately 12,000 years ago (Barnett et al., 1998). The vegetation found at KSR includes both vascular species that are native to Joker's Hill and non-native species. Most southern Ontario forests were subjected to clear cutting from European settlers in the early 1800s and disturbed via logging ever since (Suffling et al., 2003) and have been recovering since late 1800s to early 1900s (Elliot, 1998). Areas that were not reforested have naturally recovering oak, maple, beech and yellow birch forests.

This study aims to uncover the differences in understory richness and tree distribution between opposing north and south facing slopes. Specifically, we (1) counted and identified unique understory species in each slope to quantify the differences in species richness, (2) tested whether there were differences in gap fraction and leaf area index (LAI) and 3) surveyed tree biomass and distribution between the slopes to elucidate the differences in microclimate between the slopes.

Methods

Study site

The study site had to meet the following criteria: (I) Two slopes, one with a south aspect and one with a north aspect, (II) the slopes should have a similar incline (III) and both slopes should be nearby to reduce the difference in climatic factors.



Figure 1 Location of Koffler Scientific Reserve at Joker's Hill and study site where in-situ data were collected. Yellow circle denotes the location of the study site.

The study was conducted in a deciduous-coniferous forest within the property of KSR, located at 44.0302380 N and 79.5276200 W (Figure 1). It was found along a small creek that flowed in an east - west direction which had created a small valley dividing the south and north facing slopes. Both slopes were on an incline of 12.5° with minimal signs of logging and reforestation. The incline was measured using an Abney level for both plots. The site contained a variety of vegetation types, typically with Sugar Maple (*A. saccharum*) and Eastern Hemlock (*T. canadensis*).

Field collection of vegetation data

As vegetation is the central focus of our study we used several methods to observe and understand differences in vegetation. Two study plots were constructed, one plot on the NF slope and one on the SF slope. Each plot consisted of a 20 m x 20 m area that was divided into seven nested quadrats of varying size ranging from 2.5 x 2.5 m to 20 x 10 m.

In the field we utilized field guides, plant recognition smartphone applications and the KSR Herbarium. We sampled the understory and trees for identification, most often leaves were collected but any flowers or berries on the plants were also collected. We used diagnostic characters to narrow down each sample to the species level. When this was unrealistic, due to the maturity of the plant, specimens were identified to the genus. After returning from the field, all samples were pressed in a bound catalogue for safe keeping. Diameter at breast height (DBH) measurements were collected using a DBH measuring tape. These values were recorded along with the location and species of the tree within the plot. Then the tree locations were digitally mapped using Microsoft Publisher.

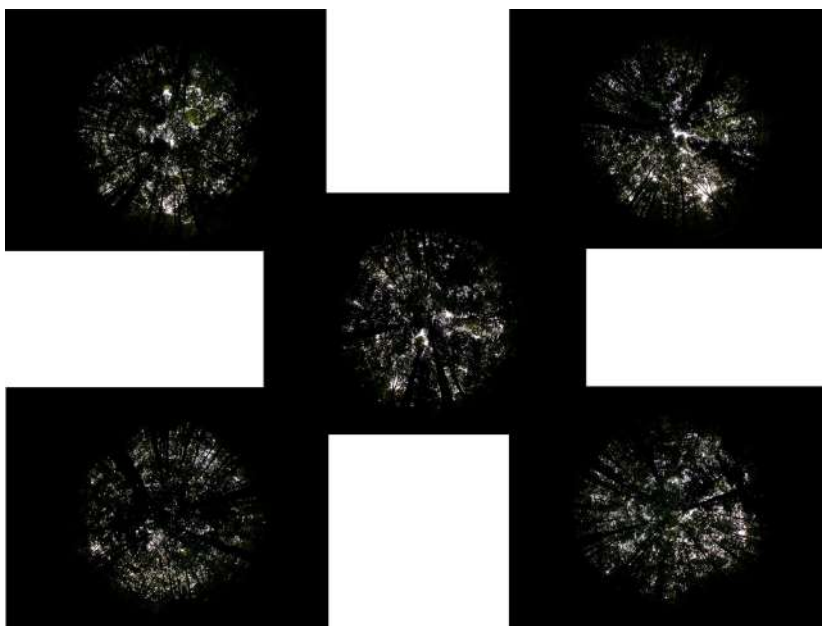


Figure 2 Spatial distribution of digital hemispherical photographs in the 20 x 20 m SF slope. Photographs were taken with following settings: aperture of 5.3 and shutter speed of 1/250 s. The same technique was used at the NF slope.

Digital hemispherical photography

A total of five hemispherical photos were taken using Nikon Coolpix 4500 with a fish-eye lens attachment, one at each corner of the plot and one in the middle of each slope to retrieve gap fraction¹ and effective plant area index² (ePAI) (Figure 2). Each of the photographs were taken with the aperture fixed at 5.3, shutter speed at 1/250 s and stored as a 2272 x 1704 pixel JPEG image. Additionally, all photographs were taken on the same day with consistent overcast to control for different weather conditions. At the time the photos were taken there was an even overcast; this gave a clear contrast between the tree leaves and the sky behind them.

The series of hemispherical photographs were analysed using Digital Hemispherical Photography 4.8b (13 July 2011) (Zhang et al., 2005). All images were analysed as 8-bit JPEG files with estimated 1590 pixels for the diameter of the 180° circular projection. The software divides the hemispherical projection into ten rings and calculates gap fraction in fixed zenithal annulus segments (Zhang et al., 2005). The blue image channel was used to analyse gap fraction, as foliage exhibits the lowest reflectivity and transmittance. This makes the foliage appear darker in comparison to the red and green bands (Zhang et al., 2005). The program then uses threshold gray values to identify pixels that are sky, foliage, and mixed pixels (both foliage and sky) (Zhang et al., 2005). The threshold values were identified from the program automatically. All photos were analysed by a single person and in the same way in order to control for consistency.

Gap fraction and LAI calculation

Leaf area index (LAI) is one half of total green leaf area per unit ground surface area (Chen & Black, 1992). For each slope, the LAI was calculated using the following equation from Chen (1996):

$$\text{LAI} = (1 - \alpha) * \text{ePAI} / \Omega \quad (1)$$

where α is the woody-to-total-area ratio; Ω is the clumping index;³ ePAI is the effective plant area index. The ePAI measurements were obtained using the DHP software. α measurements were assumed to be 0.2⁴ according to J.M. Chen of University of Toronto, St. George Campus (personal communication, November 5, 2018) and literature values (He et al., 2016). The Ω value was evaluated using the TRACWin 5.9.0 (2012.9) software with a reference zenith angle of 40.5° as both slopes had similar average gap fraction values (SF = 0.058, NF = 0.055), which was estimated to be 0.80. For the calculation of LAI, gap fraction and ePAI values from zenith angle of 85.5° were omitted as they represented the slope surface and were identified as outliers.

Percentage green cover

To approximate the understory cover in the plots of both aspects, we found the percent green cover of each quadrat. A series of photographs was taken of the forest floor in all quadrats with a Samsung Galaxy S6 rear-facing 16-megapixel camera for a total of 170 photos. Each individual photo was

¹ Gap fraction is a measure of the openness of a canopy

² Effective plant area index is an estimation of photosynthetically active radiation below canopy without accounting for clumping of the canopy components.

³ Clumping index is a quantitative description of foliage clumping

⁴ Reasoning for $\alpha = 0.2$ was too complex for the scope of this paper.

input into the TinEye Color extraction tool, which uses the TinEye MulticolorEngine API to search for colours within an image (TinEye, 2018). The tool outputs colours in percentages, and via in the green-yellow colour range, the percent green coverage was approximated for each photo. For each quadrat the average percent green coverage and standard deviation were calculated. From the average percent green cover of each quadrat we were able to compute the average percent green cover for both the NF and SF plots. Below are two photos chosen from the 170, that are representative of what the ground cover of each slope looked like



Figure 3 Sample vegetation pictures of each slope South Facing Left/North Facing Right.

Results

Plant species and richness

To understand community composition of both slopes we identified all collected specimens in our quadrats. There was a total of 34 species in the SF plot and 28 species in the NF plot. These numbers represent species richness of each slope.

A 20 m x 20 m plot proved to be suitable for exploring species richness and community structure as our species-richness curves (Figure 4) plateau as nested quadrat area increases. This is because as we increase area, the cumulative number of species increases and will start to plateau around the community size.

The SF slope fostered higher understory species richness, with a wide range of species that prefer sunlight to light-shade such as White Snakeroot (*A. altissima*). The NF slope particularly had high volumes of shade-dwelling Blue Cohosh (*C. thalictroid*).

While observations of understory abundances come from a qualitative approach, we can better understand differences in species richness between both slopes by calculating a similarity index. Sorenson's Similarity Index does not emphasize the abundances of species (Toti et al., 2000), instead we can use our species richness values to calculate similarity between north and south facing slopes. The equation for Sorenson's Similarity Index is:

$$CC = S_N + S_S \quad (2)$$

with CC representing the number of species both quadrats have in common; S_N represents species richness on north facing slope; S_S represents species richness on south facing slope. It was found that similarity in plant composition between north and south facing slopes is 0.39. To compare similarity using only tree species between slopes, a similarity of 0.77 was calculated.

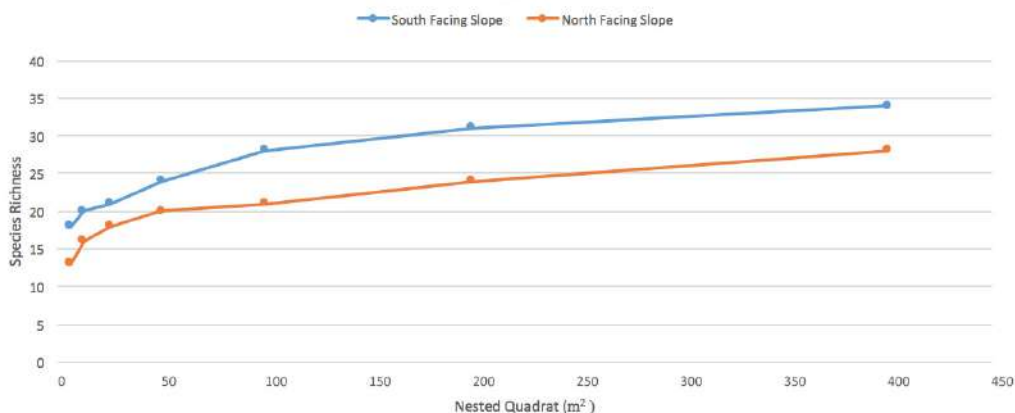


Figure 4 Species-area curves for north and south facing slopes.

Tree biodiversity indices

Biodiversity indices for trees on each slope were calculated in order to take into account species richness and species evenness. The Simpson's Diversity Index was used because it is weighted more towards dominant species (Morris et al., 2014); the equation is:

$$D = 1 - \sum n_i(n_i - 1) / N(N - 1) \quad (3)$$

where n_i is the number of individuals for each species; N is the total number of individuals of all species. The values obtained were 0.69 and 0.77 for the NF and SF slopes, respectively. Shannon's Diversity Index emphasizes species richness more than Simpson's Diversity Index (Dejong, 1975). Shannon's Diversity Index was additionally used to illustrate which slope was more diverse using the equation:

$$H = - \sum p_i \ln p_i \quad (4)$$

where p_i is the proportion of individuals for a particular species. Shannon Diversity Index resulted in values of 1.39 for the NF slope and 1.49 for the SF slope. Both indices yielded higher diversity values for the SF slope. By splitting both quadrats into four and obtaining four Shannon Diversity Indices for both slopes we were able to use a t-test which produced a p-value of 0.31, meaning differences in tree biodiversity are not significant.

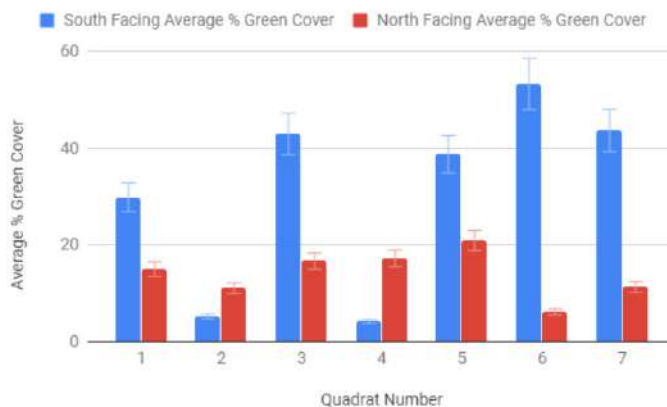


Figure 5 Bar plot of percent green cover for each quadrat with standard error bars.

Understory green cover

The percent green cover was approximated for all 170 photographs collected of the forest floor (Figure 4) by the methods discussed in section 2.5. The average percent green was variable between the different quadrats, ranging from 4.2% to 53.3%. Notably, there is more variation in the SF values, with a standard deviation of 7.52% compared with the NF standard deviation of 4.99%. The average percent cover for the entire south facing plot is 31.17% while the average percent cover for the entire north facing plot is 14.07%, with the south facing slope having 2.2 times greater percent green cover. However, the result from Welch's t-test,⁵ used due to the unequal variance between our sample populations, was a p-value of 0.59, telling us the results are not statistically significant.

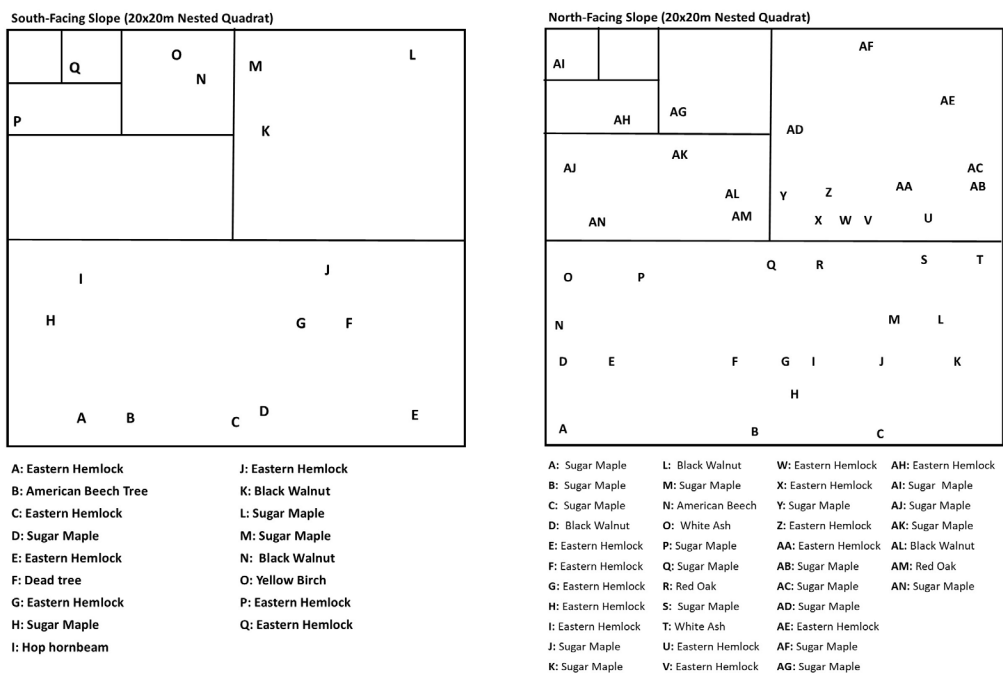
Tree distribution

In an effort to understand the potential differences between north and south facing slopes we recorded the locations of all trees with a DBH value greater than 0.1 centimetres, this was the minimum diameter that could reliably be measured with the given tools. The south facing slope has a total of 16 living trees, and one still standing dead tree. The north facing slope has a total of 40 trees. The north facing slope had a greater abundance of smaller trees at growing more densely (Figure 6a). Comparatively, the south facing slope has fewer and often larger trees with greater spacing between trees trunks (Figure 6b).

Digital image processing

To get an overall estimate of gap fraction, ePAI and LAI for the whole quadrat area, gap fraction and LAI values from the five photographs were averaged individually to produce five values per slope (Table 1). The values of overall mean gap fraction for south and north facing slopes were 0.052 ± 0.014 and 0.049 ± 0.013 respectively. The south facing slope showed the highest gap fraction in the top corners and bottom right corner of the quadrat whilst north facing slope showed highest gap fraction in the middle of the quadrat.

⁵ Also known as the unequal variances t-test, since our variances are not equal this particular t-test was selected.



Figures 6a & 6b Map of location and species of trees sampled in a) north facing and b) south facing quadrat. Species on south facing slope are labelled letters A - Q. Species on north facing slope are labelled letters A - Z, and AA - AN.

LAI calculated from eq. (1) produced 3.9 - 5.1 m²/m² for south facing slope and 4.2 - 4.8 m²/m² for north facing slope (Figure 7). However, the mean estimated LAI value was higher in north facing slope compared to south facing slope and the values were 4.65 ± 0.25 m²/m² and 4.35 ± 0.45 m²/m² respectively (Table 1).

Welch's t-test was conducted to compare the mean LAI and gap fraction of each slope. The analysis indicated that there are no statistically significant differences for both gap fraction and LAI measurements between each site; p-values were p = 0.77 and p = 0.24 respectively (Table 2). Statistical analysis was conducted using Rstudio.

DBH and biomass analysis

Using equations from Lambert et al. (2005) (see Appendix B for tree biomass equations), the biomass of each tree was calculated. Following these calculations, we were able to compare the biomass of each slope (Table 3). Table 3 shows there is more biomass on the SF slope than the NF slope by roughly 500kg. Moreover, the average tree on the SF slope is more than three times heavier than the average tree on the NF slope. Thus, the SF slope consists of fewer but heavier trees, and the NF slope consists of lighter trees.

Table 1 Average values and standard deviation of gap fraction and LAI from each photographs at each slope aspect.

Slope Aspect	Photograph Location	Gap Fraction	LAI (m2/m2)
South Facing	Top Left	0.063 ± 0.032	4.12 ± 0.88
	Top Right	0.066 ± 0.065	3.92 ± 0.56
	Middle	0.049 ± 0.042	4.32 ± 0.99
	Bottom Left	0.030 ± 0.032	5.11 ± 1.82
	Bottom Right	0.052 ± 0.018	4.30 ± 1.35
	Mean	0.052 ± 0.014	4.35 ± 0.45
North Facing	Top Left	0.038 ± 0.028	4.89 ± 0.73
	Top Right	0.042 ± 0.043	4.80 ± 0.76
	Middle	0.071 ± 0.067	4.25 ± 0.83
	Bottom Left	0.049 ± 0.052	4.74 ± 0.62
	Bottom Right	0.048 ± 0.034	4.60 ± 0.69
	Mean	0.049 ± 0.013	4.65 ± 0.25

Table 2 P-value results from comparison of gap fraction and LAI using Welch's two sample t-test.

Gap Fraction	0.7696
LAI	0.2392

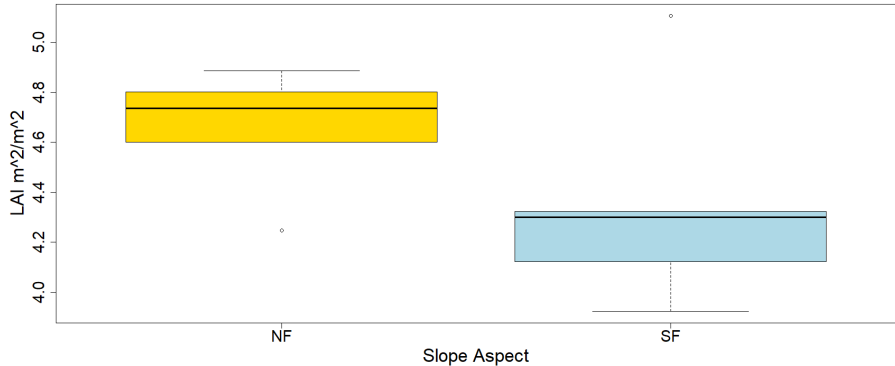


Figure 7 Vertical box plots of average LAI in m²/m² measured at each slope aspects. South facing slope is represented as light blue coloured box and north facing slope is represented as a gold coloured box. The boxes contain the median (50%) of data, top edge of the box represents 75th percentile of the data and bottom edge represents the 25th percentile of the data. The whiskers are represented by horizontal lines outside of the box which represents either the minimum or maximum values in the data. Outlier is marked as an open circle and the outlier in north facing slope represents LAI value of 4.25 m²/m² and on south facing slope represents LAI of 5.11 m²/m².

Table 3 Table of north facing and south facing tree biomass, for all trees and *T. canadensis*

Slope Aspect	# of Trees	Total Bio-mass (kg)	Estimated Biomass per hectare (ton/ha)	Average Tree Mass (kg/tree)	# of <i>T. canadensis</i>	Total <i>T. canadensis</i> Biomass (kg)	Average <i>T. canadensis</i> Biomass (kg)
South Facing	16	19,000	5200	1,200	7	7,600	1,100
North Facing	39	14,000	380	360	14	360	25

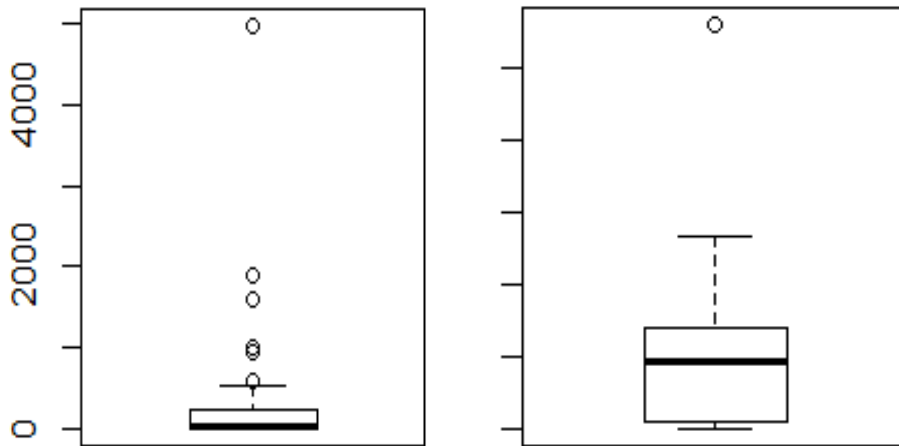


Figure 8 Box plot of tree biomass in kilograms, NF on the left, SF on the right. y-axis represents tree biomass in kilograms. Note, the extreme outliers are likely a result of large trees with a disproportionately large dbh, their mass would be overestimated by the calculations.

The box-plots show that the biomass follows a right-skewed probability distribution with the NF slope being considerably more right skewed than the SF slope (Figure 8). The NF slope has six outliers whereas the SF slope has one.

To determine if the above results are statistically significant, the statistical programming language *R*, was used to conduct a Mann-Whitney U test on the sampled trees' biomasses. The Mann-Whitney U test does not require a normal distribution or a parametric distribution, additionally, it is not swayed by outliers, thus making it a good candidate for determining the statistical significance for our data set. The Mann-Whitney U test resulted in an extremely significant p value of 0.000314, inferring that the trees on the SF slope are indeed heavier than the trees on the NF slope.

Discussion

Slope aspect, tree species distribution and succession

NF slope contained a higher number of individual trees compared to the SF slope (Figure 6a; 6b). On both slopes, *T. canadensis* and *A. saccharum* were dominant tree species whereas Yellow Birch (*B. alleghaniensis*) was only found in the SF slope. Both White Ash (*F. americana*) and Red Oak (*Q. rubra*) were only found in NF slope. Biodiversity was only calculated for the trees on each slope. Recording the abundance of the understory was not feasible in one week, therefore, biodiversity indices could not be calculated for understory vegetation. The insignificant differences in the diversity of the slopes are most likely due to understory biodiversity not being accounted for. Understory differences were most noticeable in the field, the SF slope had more vegetation of various species (Figure 3).

Biodiversity indices incorporate species richness along with evenness. Without the abundances of understory a biodiversity index including all vegetation could not be calculated. Therefore, we cannot compare biodiversity differences of total community composition between slopes. However, a similarity percentage using Sorenson's similarity index was calculated using species richness of all vegetation of each slope. When we include understory richness, the similarity between both slopes is 39%. However, when using only tree species richness, the similarity is 77%. Thus, we know that species richness in understory differs more between slopes. This could be due to differences in soil and microclimate, two characteristics that we were not able to measure. Riegel and Miller (1992) illustrated that belowground resources were primary factors in understory production. Furthermore, overstory vegetation will affect heterogeneity of light on the forest floor in temperate forests as it varies with overstory composition (Sercu et al., 2017). While we used indices that combine species richness and evenness for tree species, a study by Zilliox and Gosselin (2014) found that tree basal area is a better indicator of biodiversity, where our results found significant differences between tree biomass. Tree basal area refers to the area trees occupy, and can be derived from DBH. Using tree basal area instead of diversity indices to determine differences between slopes could also indicate biodiversity, as the basal area may be indicative of the frequency and intensity of local disturbances (Ramírez-Marcial et al., 2001).

Biodiversity of tree species between slopes depicts patterns of succession by analyzing community composition on the NF and SF slopes. Due to the history of clear cutting and logging where the plots are situated, our study area is undergoing secondary succession and the vegetation community is representative of progressive changes of regeneration. Our slope aspects affect vegetation via radiation. Light is a key resource for plant growth (Sercu et al., 2017). The SF slope is always receiving more sunlight during the day than the NF slope and this direct impact of solar radiation will affect which plants can compete on each slope (Auslander et al., 2003). Vegetation that utilizes radiation the most will be those that are in the canopy as well as those that are able to emerge further out of the canopy (Mengarda et al., 2009). Typically, species of *Betula* are early successional species that colonize a disturbed area. In our study, many dead White Birch (*B. papyrifera*) were found mainly on the NF slope; where these pioneer species could not compete with limited sunlight, more shade-tolerant species grew such as *T. canadensis* and *A. saccharum*. This occurred on both slopes as succession progressed and canopies were created from shade-tolerant species. This effect was more dramatic on the NF slope as species of *Betula* on SF slope had more radiation to aid in competition

(Auslander et al., 2003). This is demonstrated by a *B. alleghaniensis* in our SF plot which has a high biomass of 2143kg, that grew to emerge from the canopy. On both slope aspects, the dominant species are *T. canadensis* and *A. saccharum*. These species, along with less prominent hardwoods such as American Beech (*F. grandifolia*) and Black Walnut (*J. nigra*), are late successional species (Woods, 2000). These species are shade-tolerant and able to thrive later on in the succession. *T. canadensis* in particular is very shade-tolerant and often able to dominate very shaded stands (Rogers, 1978). *T. canadensis*'s ability to thrive in shaded areas may have contributed to a greater abundance and density of individuals on the NF slope.

Interspecific competition between plants is less intense on the NF slope due to higher constraint on radiation. Therefore, we are able to distinguish particular species that survive well in shade, such as *C. thalictroides*, in the understory. *C. thalictroides* occurs on both slopes, however, is able to dominate the understory of the NF slope where it is slightly more shaded.

Variation in plant growth may be due to other environmental variables such as seed growth, seed dispersion and soil characteristics. Gaps in canopy were noted as well, which would have caused certain areas to receive more radiation and have created microclimatic variations (Parker et al., 2008).

Slope aspect and LAI uncertainty

Gap fraction and LAI were found to have no significant differences between SF and NF slopes despite the NF containing 40 trees within the plot and optimizing shutter speed to 1/250 s according to the method proposed by Zhang et al. (2005). However, a study by Liu et al. (2012) suggested that optical measurements tend to underestimate LAI values up to 51%. Van Gardingen et al. (1999) also found similar results where conventional analysis of hemispherical images produced up to 50% underestimation of LAI compared to destructive harvest method. Additionally, methods that use uniform clumping index derived from direct calibration or geometric relationships are shown to produce erroneous results, especially with areas with high number of canopy gaps (Van Gardingen et al., 1999).

Slope aspect, average percent green cover and species richness

In general, the SF slope showed higher average percent green cover for five out of seven quadrats, showing a nearly two - three-fold increase in some cases (Figure 5). However, average percent green cover was found not to be significantly different between the slope aspects. Canopy cover influences the understory composition and cover as it determines how much light passes through to the ground (Lemenih et al., 2004). In our study the gap fraction and LAI were also not found to be statistically significant, a contributing factor to the lack of statistical significance for percent green cover. The SF slope had a marginally higher gap fraction from having fewer trees, which allowed more light penetration and stimulated understory growth, reflected by the higher percent green cover value of 31.17%. Conversely the NF slope was dominated by *T. canadensis* and *A. saccharum*, which marginally decreased the gap fraction and increased in LAI and resulting in a relatively lower percent green cover of 14.07%.

Both slopes have similarly gentle gradients, so we can assume that differences in plant richness and percent green cover observed between the slopes are due to soil characteristics and microclimate conditions (Pausas & Austin, 2001). If we assume percent green cover is an indication of under-story productivity and above ground biomass, then the present study shows some consistency with studies that were conducted at different regions where SF slopes showed higher productivity and species richness due to more fertile soils (Gong et al., 2008). The difference of percent green cover can be explained by the soil characteristics and according to Gong et al. (2008), soil temperature and soil water availability were significant factors that affected above ground biomass and plant productivity.

Slope aspect, DBH and tree biomass

The trees on the SF slope were heavier than those on the NF slope with the overall effect of more biomass on the SF slope. There were more than double the amount of trees on the NF slope than SF slope, many of which were small *T.canadensis*. These small trees occupied space that could have been used by fewer large trees which would result in more biomass, as was the case on the SF slope. Scholarly articles on the subject of slope aspect, tree biomass, and tree distribution did not have consistent results. Måren et al. (2015) found trees to be larger and more abundant on SF slopes in the Himalayas. However, Sharma et al. (2011) found the opposite to be true in India in respect to tree biomass and abundance. One consistency among studies, however, was that NF slopes had more biomass than SF slopes. All of the following studies: Måren et al. (2015); Hu et al. (2018); Sharma et al. (2011)—which took place in India, Nepal and China respectively—found this to be true.

It is important to remark, the studies mentioned take place in high altitude mountains whereas the study site at KSR is in southern Ontario. This makes the study site at KSR less prone to droughts, strong winds and forest fires. At high altitudes these factors are more prevalent on SF slopes, which may explain why there is less biomass (Sharma et al., 2011).

A study conducted in Pennsylvania compared the biomass of a NF slope and a SF slope, both of 11° incline in a humid temperate forest, at a similar altitude to the site at KSR (Smith et al., 2017). This study's results did not contradict the results found at KSR. The biomass of the SF slope was found to be 20% greater than that of the NF slope (Smith et al., 2017).

How radiation interacts with the environment of the slopes will determine how slope aspect affects biomass. Smith et al. (2017) claims the NF slope of the oak hickory forest studied in Pennsylvania showed evidence of temperature constraints, whereas the SF slope did not. Meanwhile in higher altitude mountains, forest fires, drought and windfall restricted biomass on the SF slope (Sharma et al., 2011).

More detailed analysis of the environment at KSR would be needed to draw conclusions as to why there is more biomass and fewer trees on the SF slope. Temperature, soil texture, soil moisture, seasonal analysis and long term observations would all help determine how the difference in solar radiation changes the environment of the slopes in a way that explains the results attained at KSR.

Conclusion

Our study did not find significant differences in canopy characteristics (gap fraction and LAI), percent understory cover, and species richness between NF and SF slopes. In both plots of Figure 6a and 6b, *T. canadensis* and *A. saccharum* were dominant species whilst *Q. rubra* and *F. americana* were found in small numbers on the NF slope. *B. alleghaniensis* was found only on the SF slope. Tree biomass of SF slope was significantly higher. While there is some difference between slopes of differing aspect, aspect is certainly not a singular control.

In order to better understand both the differences and similarities of vegetation on slopes of differing aspect, more research is needed. In particular, the investigation of further variables such as soil moisture, pH, percent organic matter, and soil texture would be useful for understanding the differences in species composition of both the understory and overstory. Further, collection of radiation data for both slopes may be vital as radiation governs the physical processes that occur within the forest (Måren et al., 2015). Seasonality could also be examined as radiation, moisture, and plant growth are all influenced by seasonality. We have only a very limited snapshot of the vegetation in late summer, thus it would be informative to record how the makeup of each slope changes throughout the year. Further research in the potential differences between aspect and vegetation can be useful for better understanding forest characteristics in relation to both conservation and reforestation efforts. As well, it is inherently valuable to build a nuanced understanding of the complexities of forest communities, especially as climate change continues to impact forest communities.

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Appendix A Slope Aspect and Solar Radiation

Due to the location of our study area in the northern hemisphere, the sun will always be on the southern side of the sky, ie. the shadows will never be on the south side of an object. Figure 9 illustrates the angle between the surface of the Earth at our study area when the Sun's rays are at midday during the equinox. The sun's angle will be at 45.97° to the astronomical horizon (flat ground), or equivalently 44.03° to the direction of gravity.

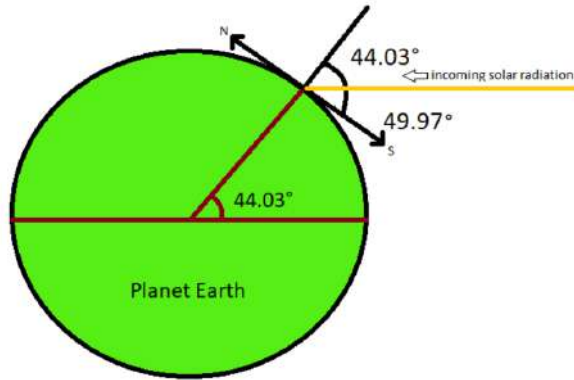


Figure 9 The angle of solar radiation when reaching our study site during the equinox.

Both on-site slopes had a grade of 12.5° , and Figure 10 illustrates how the aspects of each slope will affect the intensity of solar radiation. Incoming solar radiation makes more direct impact with the SF slope, whereas on the NF slope, the same amount of radiation is stretched out over greater surface area. Therefore, on any given day, there is more radiation per unit square meter on the surface of SF slope than on the NF slope.

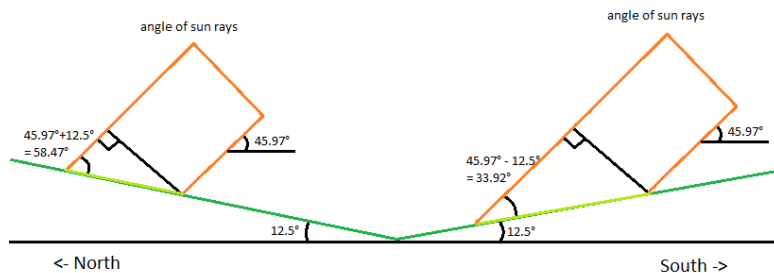


Figure 10 Illustration of the angles that solar radiation makes with the NF and SF slopes. Solar radiation is represented as orange lines and the dark green lines represent NF and SF slopes. The area on the slope that the selected radiation will illuminate is represented by the light green line.

Specifically, the radiation has to extend 6% of its original radiation length to cover the SF slope. Conversely, the radiation on the NF slope has to spread 68% times its original length. This results the SF slope receiving 58.5% more radiation than the NF slope during equinox at midday. This difference in radiation will be even more intense in the winter, and less so in the summer due to the changing tilt of the Earth.



Figure 11 A screenshot of the two slopes in google maps 3D. The yellow line roughly outlines the profile of the slopes being studied, and the pin marks the GPS coordinates (44.03591, -79.532229) of the creek between the two slopes. The left slope is the SF slope, and the right slope is the NF slope.

When looking at the study area with Google Maps' 3D satellite view (Figure 11), the two slopes are still visible while only being able to see the canopy. This means the effects that slope aspect has on radiation intensity will be present in the forest canopy. Thus, there is more solar radiation on the SF canopy than the NF canopy.

When studying the amount of radiation available on the forest floor, one must consider the factors explained above, as well as the different amounts of canopy cover the radiation has to travel through in order to reach the forest floor. Figure 12 illustrates how the radiation hitting the forest floor of the NF slope must pass through more canopy cover then the SF slope. The dark green is the intersectional area underneath the forest canopy that interferes with the the selected sample of radiation.

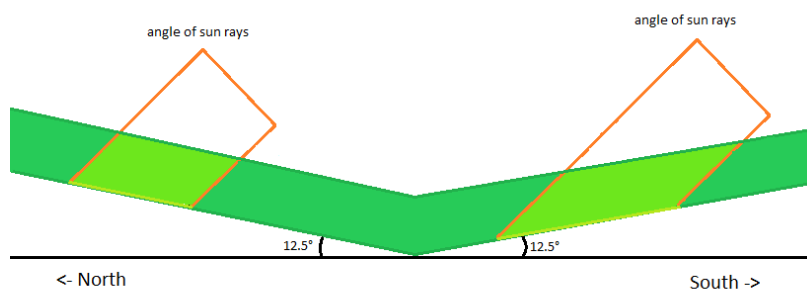


Figure 12 Illustration of the different amount of canopy cover the radiation has to travel through in order to reach the forest floor of each slope. The area outlined in orange is a selected portion of radiation, the dark green is the forest canopy, and the light green is the intersection between the forest canopy and selected radiation.

Appendix B Tree Biomass Equations

The following equations from Lambert et al. (1996) were used to calculate tree biomass:

$$\begin{aligned}y_{\text{wood}} &= \beta_{\text{wood}1} D^{\beta_{\text{wood}2}} + e_{\text{wood}} \\y_{\text{bark}} &= \beta_{\text{bark}1} D^{\beta_{\text{bark}2}} + e_{\text{bark}} \\y_{\text{stem}} &= \hat{y}_{\text{wood}} + \hat{y}_{\text{bark}} + e_{\text{stem}} \\y_{\text{foliage}} &= \beta_{\text{foliage}1} D^{\beta_{\text{foliage}2}} + e_{\text{foliage}} \\y_{\text{branches}} &= \beta_{\text{branches}1} D^{\beta_{\text{branches}2}} + e_{\text{branches}} \\y_{\text{crown}} &= \hat{y}_{\text{foliage}} + \hat{y}_{\text{branches}} + e_{\text{crown}} \\y_{\text{crown}} &= \hat{y}_{\text{wood}} + \hat{y}_{\text{bark}} + \hat{y}_{\text{foliage}} + \hat{y}_{\text{branches}} + e_{\text{total}}\end{aligned}$$

where D is the DBH of a sampled tree; β is the species specific constant; $\hat{y}$ is the biomass of a tree section (eg: tree bark, tree foliage); e is the error correcting the equation; y is the true value. y_{crown} is the sum of each tree part's biomass, which estimates the biomass of the entire tree.

